This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

THE ROCKEFELLER FOUNDATION

INTERNATIONAL HEALTH BOARD

EIGHTH ANNUAL REPORT

January 1, 1921—December 31, 1921

61 Broadway, New York, N. Y., U. S. A.

1922

Public Health
gft
Dr. Henry F. Vaughan
10-16-47

INTERNATIONAL HEALTH BOARD

Report of the General Director

To the President of the Rockefeller Foundation:

Sir:

I have the honor to submit herewith my report as General Director of the International Health Board for the period January 1, 1921, to December 31, 1921.

Respectfully yours,
WICKLIFFE ROSE,
General Director.

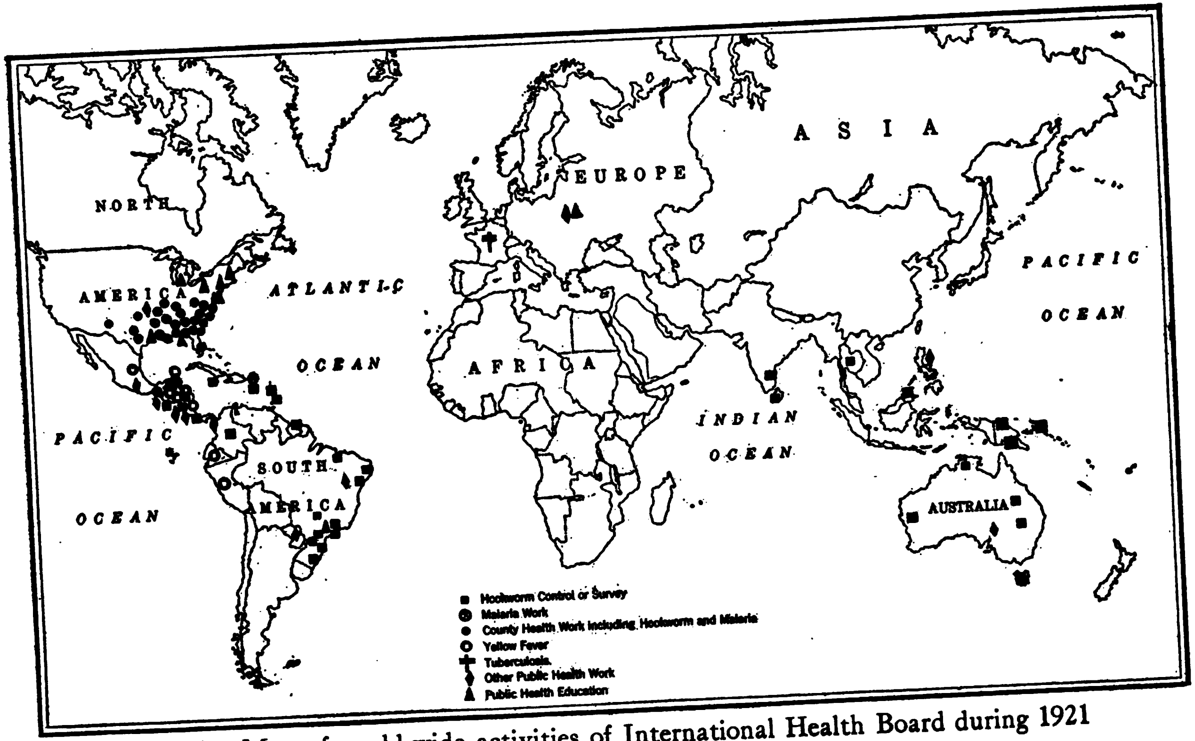


Fig. 1.—Map of world-wide activities of International Health Board during 1921

INTERNATIONAL HEALTH BOARD

OFFICERS AND MEMBERS

George E. Vincent, *Chairman*
Wickliffe Rose, *General Director*
Hermann M. Biggs
Wallace Buttrick
Simon Flexner
Raymond B. Fosdick
Frederick T. Gates
Edwin O. Jordan
T. Mitchell Prudden
John D. Rockefeller, Jr.
Frederick Strauss
Victor C. Vaughan
William H. Welch

Edwin R. Embree, *Secretary*
Florence M. Read, *Assistant Secretary*

PERSONNEL OF STAFFS DURING 1921[1]

ADMINISTRATIVE STAFF

WICKLIFFE ROSE, *General Director*
JOHN A. FERRELL, M.D., *Director for the United States*
VICTOR G. HEISER, M.D., *Director for the East*
HECTOR H. HOWARD, M.D., *Director for the West Indies*
L. W. HACKETT, M.D., *Associate Regional Director (for Brazil)*
FREDERICK F. RUSSELL, M.D., *Director of Public Health Laboratory Service*

FIELD STAFF

HOOKWORM

AUSTRALIA (including Papua and late German New Guinea)	W. A. Sawyer S. M. Lambert[2] C. N. Leach W. C. Sweet[2]
BRAZIL	L. W. Hackett G. K. Strode Paes de Azevedo (resigned)
Alagoas	F. L. Soper (survey) Alan Gregg
Espirito Santo	G. K. Strode Alan Gregg (survey) J. H. Janney[2] (survey)
Pernambuco	Alan Gregg F. L. Soper
Rio de Janeiro	G. K. Strode
Rio Grande do Sul	Alan Gregg F. L. Soper
Santa Catharina	Alan Gregg F. L. Soper
São Paulo	G. K. Strode
BRITISH NORTH BORNEO	C. H. Yeager

---

[1] Personnel employed by Government in co-operative work not listed.
[2] Special Staff Member.

British Solomon Islands (survey)	S. M. Lambert[1]
Ceylon	W. P. Jacocks G. G. Hampton C. N. Leach S. A. Winsor (resigned)
Colombia	F. A. Miller
Costa Rica	Louis Schapiro J. E. Elmendorf, Jr.
Dutch Guiana	W. C. Hausheer
Guatemala	E. I. Vaughn J. E. Elmendorf, Jr.
India	J. F. Kendrick G. P. Paul
Jamaica	B. E. Washburn
Nicaragua	D. M. Molloy
Panama	F. C. Caldwell
Porto Rico	R. B. Hill
Salvador	C. A. Bailey
Siam	M. E. Barnes H. R. O'Brien[1]
Trinidad	G. C. Payne W. C. Hausheer J. L. Rice[1]

COUNTY HEALTH WORK IN UNITED STATES

Alabama	F. W. Dershimer A. L. McKay (resigned)
Indiana	G. P. Paul
Kansas	A. J. Warren
Kentucky	P. W. Covington

---

[1] Special Staff Member.

Louisiana	P. W. Covington Hugo Muench, Jr.[1]
New Mexico	J. F. Docherty D. B. Wilson
Texas	A. P. Harrison[1]

MALARIA

Alabama	E. B. Johnson[1] (resigned) William Ropes[1]
Arkansas	F. P. Gilbert[1] L. G. Hastings[1] (resigned) William Ropes[1]
Louisiana	L. J. Petritz
Mississippi	C. C. Bass[1] J. L. Clarke[1]
Missouri	M. F. Boyd
Nicaragua	F. E. Hulse[1]
North Carolina	H. A. Taylor C. E. Buck[1] (resigned) J. J. Mieldazis[1]
Porto Rico	H. W. Green[1]
South Carolina	J. J. Mieldazis[1]
Tennessee	H. A. Johnson[1] N. H. Rector[1]
Texas	E. H. Magoon[1] Geo. Parker[1]
Virginia	E. H. Gage[1] (resigned)

YELLOW FEVER

Yellow Fever Advisory Council[2]

Henry R. Carter, M.D., Assistant Surgeon General, United States Public Health Service

---

[1] Special Staff Member.

[2] Not Staff Members; appointed to serve in an advisory capacity.

Juan Guiteras, M.D., Secretary, Department of Health and Charities, Cuba
Hideyo Noguchi, M.D., Rockefeller Institute for Medical Research
Joseph H. White, M.D.,[1] Assistant Surgeon General, United States Public Health Service

MEXICO AND CENTRAL AMERICA	T. C. Lyster[1]
British Honduras	E. I. Vaughn
Guatemala	E. I. Vaughn H. K. Marshall[1] (resigned) T. F. Botello[1]
Honduras	E. I. Vaughn C. A. Bailey
Mexico	J. H. White[1] B. W. Caldwell[1] M. E. Connor W. M. Monroe E. I. Vaughn
Nicaragua	D. M. Molloy
Salvador	C. A. Bailey W. H. Davies[1] (resigned)
PERU	J. H. White[1]

TUBERCULOSIS

FRANCE	L. R. Williams[1] Alexander Bruno[1] F. Elisabeth Crowell[1] B. L. Wyatt[1] (resigned)

SPECIAL

AUSTRALIA—PUBLIC HEALTH ADMINISTRATION

A. J. Lanza[1]—Lent to Department of Health for two years to assist in organization of Department of Industrial Hygiene

F. F. Longley[1]—Lent to Department of Health for two years to assist in organization of Department of Sanitary Engineering

BRAZIL—COUNTY HEALTH WORK

J. H. Janney[1]

PUBLIC HEALTH NURSING SERVICE

Mrs. Ethel Parsons[1]

SCHOOL OF HYGIENE AND PUBLIC HEALTH, SÃO PAULO

W. G. Smillie, Director and Professor of Hygiene

---

[1] Special Staff Member.

China—Special Service

J. B. Grant—Lent to Peking Union Medical College as Associate Professor of Hygiene and Public Health

Czechoslovakia—Public Health Administration

S. M. Gunn[1]

Paraguay—Public Health Survey

L. W. Hackett

Philippine Islands—Public Health Survey

V. G. Heiser

ON LEAVE

(for whole or part of year)

W. T. Burres
S. T. Darling[1]
H. H. Howard
J. J. Mieldazis[1]
Louis Schapiro

AT HOME OFFICE

C. W. Wells (in charge of fellowships)
J. L. Hydrick

ENGAGED IN SPECIAL STUDY (Johns Hopkins School of Hygiene and Public Health)

S. T. Darling[1]
J. B. Grant
Louis Schapiro

IN TRAINING

Australia	C. N. Leach W. C. Sweet[1]
Brazil	J. H. Janney[1]
Ceylon	C. N. Leach
Mexico	W. M. Monroe
Siam	H. R. O'Brien[1]
Tennessee	H. A. Johnson[1] N. H. Rector[1]

---

[1] Special Staff Member.

TABLE OF CONTENTS

PAGE

PROMOTING HEALTH IN MANY LANDS

INTERNATIONAL CO-OPERATION IN YELLOW FEVER CONTROL.... 1
Fighting an Epidemic in Peru.... 3
Controlling the Epidemic with Fish.... 5
Yucatan a Historic Center of Infection.... 6
Winning by Team-Play.... 9
Government Continuing the Attack in Brazil.... 12
Yellow Fever Commission to West Africa.... 13
The Noguchi Vaccine and Serum.... 14

EXTENDING THE FRONT AGAINST MALARIA.... 15
Malaria Control on a County-Wide Scale.... 18
Field Experiments in Malaria Control.... 21

FIGHTING TUBERCULOSIS IN FRANCE.... 22

USING THE HOOKWORM IN PROMOTING PUBLIC HEALTH.... 26
The First Field Demonstration.... 28
Results in Eleven States.... 30
Board's Work Completed.... 32
Testing Results in Brazil.... 33
Transferring Responsibility to Brazilian Government.... 35
Progress in Permanent Sanitation in West Indies.... 36
Developing National Health Organization in Central America.... 39
Promoting Public Health in the Far East.... 41
On Their Own Initiative.... 45
Greater Speed and Economy in Field Operations.... 46
Field Studies in Hookworm Control.... 47

DEVELOPING SCHOOLS OF HYGIENE.... 49
Fellowships in Hygiene and Public Health.... 51
Extension Courses in Public Health.... 52

PROMOTING COUNTY HEALTH WORK.... 55
Experiment in County Health Administration.... 56

MAKING PUBLIC HEALTH LABORATORIES MORE SERVICEABLE.... 57

ESTABLISHING A PUBLIC HEALTH NURSING SERVICE IN BRAZIL.... 59

LAYING FOUNDATIONS IN CZECHOSLOVAKIA.... 60

PUBLICATIONS.... 61

PAGE

APPENDIX

I Extent and Severity of Hookworm Disease 67
II Life of Hookworm Eggs and Larvae in the Soil 81
III Diagnosis of Hookworm Disease 90
IV Malaria Control 93
V Fighting Mosquitoes with Fish 106
VI County Health Work 112

STATISTICAL TABLES

Table 1: Persons Examined and Treated for Hookworm Disease, 1910 to 1921, Inclusive 124
Table 2: Expenditures of the International Health Board 136

ILLUSTRATIONS

PAGE
Map of world-wide activities of International Health Board....... vi
Yellow fever map of the Western Hemisphere................... 2
Scene of the violent yellow fever epidemic in Peru during 1921...... 4
Three aspects of yellow fever control effort in Peru during 1921..... 7
A small model showing the types of water containers used about the dwellings in Merida, Yucatan.............................. 8
Shallow, driven tubular well for preventing Stegomyia breeding, Corinto, Nicaragua... 8
Map of Mexico and Central America showing towns visited by yellow fever in 1921... 11
Yellow fever cases in Mexico and Central America, 1920 and 1921... 12
What malaria has cost the towns of Bamberg and Chester, South Carolina, during the years 1918 to 1921...................... 16
Reduction in physicians' calls for malaria in Groveton and South Groveton, Texas.. 17
Record of malaria incidence for town of Hamburg, Arkansas...... 19
How malaria has been brought under control in Crossett, Arkansas.. 20
Tuberculosis exhibit at Pasteur Institute, Paris................. 23
Traveling educational units which have met with marked success in the anti-tuberculosis work in France....................... 24
The hookworm story of Richmond county, Virginia.............. 28
Decline in incidence of dysentery and typhoid fever, Troup county, Georgia.. 31
Appropriations of legislatures to state boards of health in eleven southern states, 1910–1921................................ 32
Control of hookworm disease as result of campaign measures applied in 1918 in Jacarepagua, Brazil......................... 34
Reduction of hookworm disease as result of control measures, Governor's Island, Brazil.................................... 34
Effect of treatment and installation of latrines on severity of hookworm infection.. 35
Increase in funds for rural sanitation appropriated by Federal and local governments in Brazil, 1917–1921...................... 36
States of Brazil that have funds available for a program of rural sanitation.. 37
Reduction of hookworm infection rate on estates in the Vere area, Jamaica... 38
Carrying the gospel of sanitation to the natives of Solomon Islands.. 43

PAGE
Group of Moors assembled at village dispensary, Ceylon.......... 43
Three phases of field operations against hookworm disease in Papua. 44
Counting hookworms expelled by treated patients................ 53
Group assembled at typhoid exhibit at Prague................. 53
Counties having full-time health officers at close of 1921.......... 54
Localities visited in investigation into the incidence and effects of hookworm disease in Madras Presidency, India................ 68
Incidence of bowel complaints, Trichinopoly jail, India, 1918 to 1921 70
Worms harbored by 1,878 prisoners examined in Trichinopoly jail, India.. 71
Ancient temples in Siam put at service of hookworm commission.... 73
Groups of natives assembled for treatment, Tupile, Panama...... 74
Average number of worms harbored by seventy-four coolies at work on the Mudis téa estates, Madras Presidency, India........... 76
Average daily number of patients in Lionel Town hospital, Vere area, Jamaica, 1918–1921.................................. 77
Effect of hookworm treatment administered in the Rio Cobre Home, Jamaica.. 78
Hemoglobin indices of 18,514 persons in Costa Rica............. 79
Group assembled to hear lecture and receive treatment for hookworm disease, Fusagasugá, Colombia........................ 83
Exhibit on hookworm disease at the National Agricultural Exposition, Brisbane, Australia.................................. 83
Negro family, residents of Federal District, Brazil............... 84
Examining board and other apparatus used in Jamaica in examining fecal specimens by the salt-flotation process.................. 84
Number of persons examined and treated in world-wide campaign against hookworm disease, 1910–1921........................ 87
Sanitary conditions on first and last inspections compared for the five main geographical divisions of world-wide campaign against hookworm disease, 1910–1921.............................. 88
Ditch along railroad embankment, before and after draining, Demopolis, Alabama.. 95
"V"-shaped ditch, a part of the drainage system installed to control malaria in and near La Puebla-Rivas, Nicaragua.............. 95
Anti-malaria, impounding water experiment at Mound, Louisiana. View across bayou, 700 yards above dam site, before clearing..... 96
Same as Fig. 47, showing bayou filled with water................ 96
Quinine treatment controls malaria, Sunflower county, Mississippi; graph based on history index............................... 101
Proportionate rates of sickness from malaria and other diseases among rural population of seven counties in Southeast Missouri......... 104

PAGE
Effect of screening and construction of houses on incidence of malaria, two Southeast Missouri townships 105
Several phases of yellow fever operations in Mexico and Central America 107
Tank at Colima, Mexico, from which are distributed the small fish placed in water containers at the homes 108
Transporting fish from landing place to headquarters 108
Growth in funds set aside for county health work, nine southern states, 1917–1921 112
Reduction of hookworm infection rates, 1911 to 1921, in fifty-two counties in ten southern states 113
Average number of deaths from typhoid fever per hundred thousand population, nine North Carolina counties 114
Health officer vaccinating children in rural school of Mason county, Kentucky 115
Trachoma clinic at Maysville, Kentucky 115
Class of midwives, with their instructor 116
Children assembled to receive diphtheria immunization, Tyndale school, Lenoir county, North Carolina 116
Control of typhoid fever in Pearl River county, Mississippi 119

PROMOTING HEALTH IN MANY LANDS

The period of three years since the armistice has been one of unprecedented activity in government organization for war on disease: new national health services, including new ministries of health, have been created in England, France, Australia, Czechoslovakia, Poland, and the kingdom of the Serbs, Croats, and Slovenes; in other countries national and state services have been reconstituted with enlarged powers and resources; public funds for health purposes have been enormously increased; and the call for qualified men is being met by the establishment of institutions to provide the training required. During the year 1921 the International Health Board has shared in activities designed to promote this movement in sixty-three states and countries throughout the world.

I

International Co-operation in Yellow Fever Control

There are important public health functions which are essentially international in character. No nation acting alone can perform them. Among these is the control of the great epidemic plagues of which yellow fever is a conspicuous example. For more than 200 years prior to the work of Reed and his colleagues at Havana the tropical and semi-tropical regions of the Americas had been subject to devastating invasions of this disease. During this period appalling epidemics swept repeatedly over the coastal regions of Brazil as far south as Rio de Janeiro, up the Amazon valley, along the Caribbean littoral, throughout the West Indies, Central America, Mexico, and the southern United States, and over the west coast of America from Callao in Peru to Mazatlán in Mexico. The infection had crossed the sea to West Africa; had apparently become endemic there; and had appeared from time to time in places as remote from its original source as England, France, Spain, and Italy. No country had the power of self-defense. Despite the

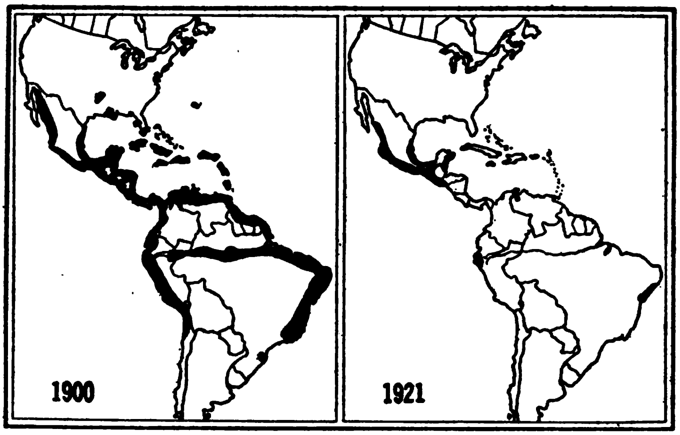


Fig. 2.—Yellow fever map of the Western Hemisphere. The shading indicates localities in which one or more cases of the disease appeared. Compare 1921 with 1900. The disease is steadily retreating as the concerted attack progresses

most rigid quarantine regulations the infection overran national boundaries, decimating populations, paralyzing industry and trade, and holding the people of these regions in a state of perpetual dread.

Reed and his commission discovered the key to yellow fever control. By international concert of effort the infection, so far as the Western Hemisphere is concerned, has been pretty well delimited and its boundaries are being steadily driven in (see Fig. 2, page 2).

Fighting an Epidemic in Peru

The Pacific coast from Panama to Callao in Peru is treated as a unit. Since the days of Gorgas in Panama a low Stegomyia index steadily maintained has protected that community against reinvasion. Recent inspection in Buenaventura, Colombia, indicates satisfactory conditions with no traces of danger in that port of entry. No case has been reported from Ecuador since May, 1919. Dr. Pareja, local health officer, is holding the mosquito index in Guayaquil below the danger point as a safeguard against reinvasion from Peru.

The scene of active operations on this coast during 1921 has been in Peru. At some time preceding its elimination from Ecuador in 1919 it had crossed the border into Peru and had become well established there before being recognized as yellow fever. Because of limited funds and lack of trained personnel, first efforts at control were on an inadequate scale. By March, 1920, the disease had appeared in serious epidemic form over a wide region in the department of Piura and is estimated to have numbered about 6,000 cases before its final suppression in August of that year. Again the infection escaped. Just before its final extinction in Piura it had crossed a desert zone which had been depended upon to protect the region farther south, and under the guise of "acute malaria" had established itself in the department of Lambayeque. With a dense, non-immune population and an extremely high Stegomyia index—from 60 to 100 per cent—it spread with great rapidity. From Lambayeque the epidemic extended south through the department of Libertad with an estimated total of from 10,000 to 15,000 cases.

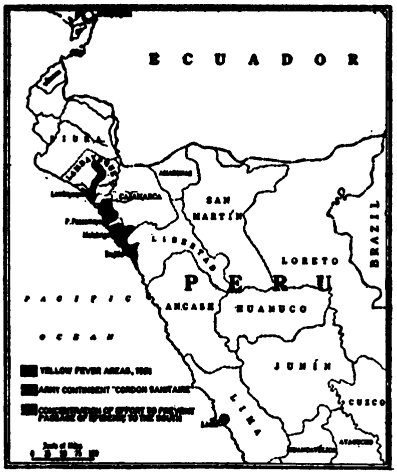


Fig. 3.—Scene of the violent yellow fever epidemic in Peru during 1921

Controlling the Epidemic with Fish

In February, 1921, Government placed Doctor Henry Hanson in charge of the campaign with full authority. The International Health Board was called upon to supplement available funds. Competent local physicians were enlisted; a limited number of trained inspectors were brought down from Panama; and as rapidly as possible systematic operations were organized to cover not only the infected area but also a considerable barrier zone lying south of the region of known infection. All effort was centered on the control of Stegomyia breeding.

Here as in Guayaquil the result was finally accomplished by enlisting two local species of fish to devour the eggs and larvae of the mosquito. An attempt in the beginning of the campaign to teach the people to prevent breeding on their own premises failed. Everything had to be done by the mosquito squad. Effort to keep water containers covered was equally unsuccessful. Straining the water (which in that dry country was too precious to be turned out) involved an amount of labor that made it impracticable for a region so vast. It was found that by distributing fish—two to four small fish to a container holding ten to fifteen gallons—the problem was simplified by about 75 per cent, with a lower resulting mosquito index than it had been possible to get in any other way. The 750,000 fish distributed in this drive conquered the epidemic. The last case was reported from Libertad on July 16.

No case has been reported from Piura since August, 1920, and there has been no known case anywhere in Peru since July, 1921. So vast, however, is the region covered by the epidemic and so often has the infection lingered unrecognized in remote communities that one would not venture at this time to declare the country free. As a precaution against the reappearance of the disease the drive against Stegomyia is to be continued up to May, 1922. It will cover the entire region from Ecuador to Callao—a distance of 500 miles—and from the sea back to the mountains—a zone varying in width from fifty to seventy-five miles. If up to that time no case shall have appeared the forces will be demobilized.

Yucatan a Historic Center of Infection

As Guayaquil for more than seventy-five years had served as the endemic focus from which yellow fever has spread from time to time over the Pacific coast, so Merida, in Yucatan, has been regarded by sanitarians as an important seed-bed of long standing from which the infection has been distributed repeatedly throughout Mexico and the Central American countries.

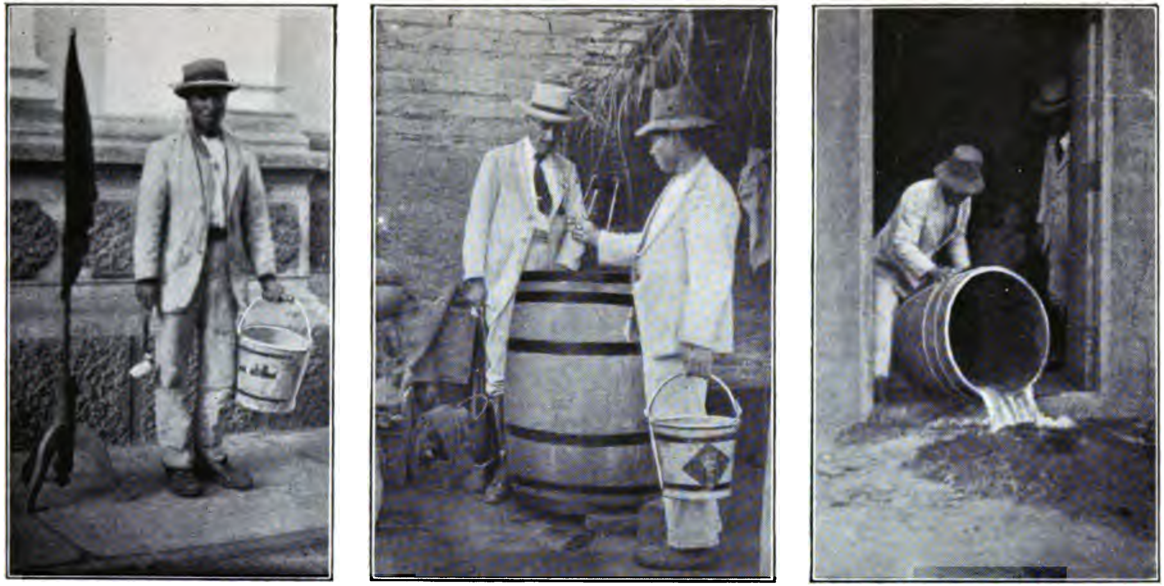


Fig. 4.—Three aspects of yellow fever control effort in Peru during 1921. *Left:* sanitary inspector with equipment carried on his rounds; *center:* stocking a water container with small fish to devour the Stegomyia larvae; *right:* emptying a container as a preliminary to refilling with pure water and stocking with fish

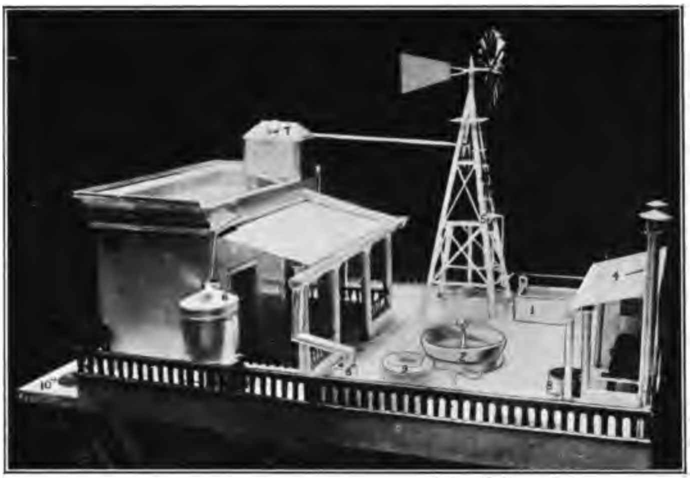


Fig. 5.—A small model showing the types of water containers used about the dwellings in Merida, Yucatan. The exhibition of this model, made of scrap tin by an inspector in his spare time, did much to arouse the interest of householders in preventing mosquito breeding

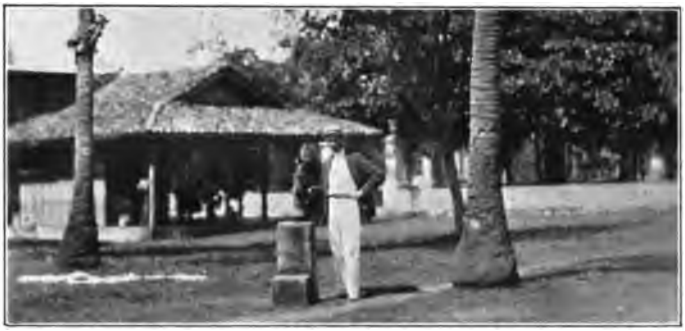


Fig. 6.—Shallow, driven tubular well for preventing Stegomyia breeding, Corinto, Nicaragua. The placing of fish in the open wells of this town freed the water of larvae, but frequent careful inspection was necessary. The driven well has solved the problem. A small block and platform of concrete are adequate to protect it

Recent archeological studies in Yucatan have given the subject an added interest. They bring to light the records of devastating yellow fever epidemics in the Maya cities of this densely populated region antedating the Spanish invasion. It is to this cause Dr. Spinden[1] attributes the depopulation of these ancient cities and the decay of Maya civilization in the lowlands bordering the Gulf. It is one of the great plagues of the early Spanish records. Throughout modern times it has remained a scourge of this region, with Merida as an important source of infection. Within the last few years the disease has appeared in epidemic form throughout eastern Mexico, on the Mexican Pacific coast from Mazatlán to Guatemala, in Guatemala, Salvador, Nicaragua, Honduras, and British Honduras.

Winning by Team-Play

No one of these countries acting alone could protect itself. The effort was much like attempting to empty a spring with a spoon. Guatemala, for example, suppressed an epidemic which had spread to sixteen communities on the Pacific coast in 1918, only to have the infection reintroduced the following year. Now, by international co-operation, control measures over this entire region are being administered as a unit. Active operations in each country are being carried out by a yellow fever commission created by special decree, under the national departments of health and clothed with authority. The necessary unity of effort is secured by the simple device of giving the International Health Board representation on each of these commissions.

---

[1] Yellow Fever—First and Last. By Herbert J. Spinden. *World's Work*, December, 1921, p. 169–181.

This united drive opened in Salvador, Nicaragua, Guatemala, and Honduras in 1920; in Mexico in January, 1921; and in British Honduras in August, 1921. The Mexican department of health had been active on its own account during the previous year and had done much to reduce the severity of the epidemic that had swept over the eastern part of that country from Yucatan to Tampico. In this campaign as in Peru effort is centered on the control of Stegomyia breeding. The problem has been enormously simplified by permanently sealing the domestic tanks and by using larvae-devouring fish in all containers holding sufficient water to support fish life. By the introduction of these two simple devices in Guayaquil in 1919 Dr. Connor had been able to reduce his field staff for a given area from 139 men to twenty men. Experience during 1921 abundantly confirms the result.

War on the mosquito is conquering the disease. At the present time there seems to be no yellow fever in Merida or anywhere in Yucatan. The important base ports of Campeche, Vera Cruz, Túxpan, and Tampico are being held with a Stegomyia index sufficiently low to prevent the transmission of infection within these communities; and from these centers control measures are being gradually extended to the outlying communities. A smouldering infection still remains in a back-country region about Papantla; in a densely populated agricultural valley west from Cosamaloapan in the southern part of the state of Vera Cruz; and along the Gulf coast in British Honduras from Belize to Santa Cruz de Bravo in Quintana Roo. Within recent months system-

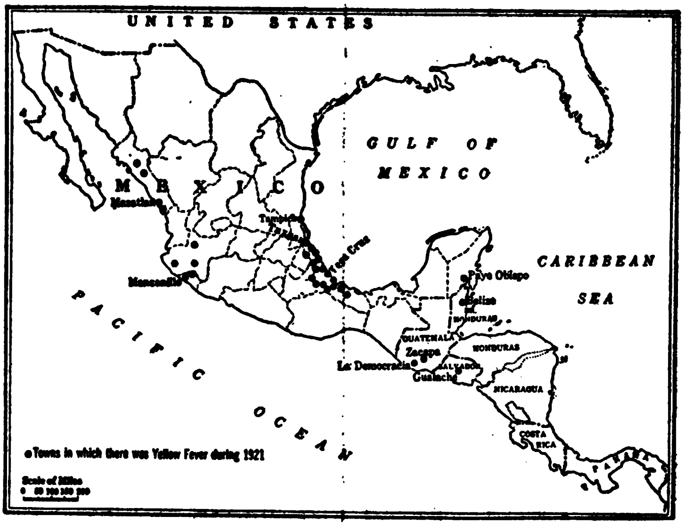


Fig. 7.—Map of Mexico and Central America showing towns visited by yellow fever in 1921

atic mosquito control has been undertaken on the Mexican Pacific coast, where the infection seems to have been appearing from time to time for the last three years over a vast region from Manzanillo to Mazatlán. These remaining areas of infection should involve no particular difficulties. No case of yellow fever has been reported from Nicaragua, Salvador, Guatemala, or Honduras for more than ten months. The number of cases reported from Mexico and Central America for 1920 was 710; for 1921 the total number of reported cases is 145, as shown in Fig. 8.

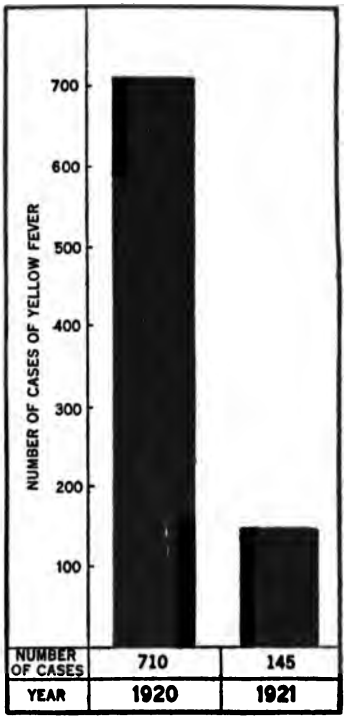


Fig. 8.—Yellow fever cases in Mexico and Central America, 1920 and 1921. Control effort is being continued to stamp out the infection

Government Continuing the Attack in Brazil

The other remaining center of yellow fever on the Western Hemisphere is in Brazil. The infection, formerly covering the entire coast from

Rio de Janeiro north and up the Amazon valley to Yquitos in Peru, seems now to be confined to a narrow coastal zone from Pernambuco to Bahia. These two cities are presumably the endemic foci. In April an epidemic was reported in the state of Bahia. It had apparently been in progress for months, had spread over a considerable area, and numbered from 400 to 500 cases. Cases were reported also from Natal in Rio Grande do Norte, from Porto Calvo, Alagoas, and from the district between Alagoas and Pernambuco.

Until the last vestige of yellow fever has been stamped out here this region must be recognized as a constant menace to the rest of Brazil, to the coasts of Venezuela and Colombia, and to the neighboring West Indies. Freedom from the disease for a considerable period has given opportunity for the development in these countries of a non-immune population. A reinvasion at this time would probably be vastly more disastrous than it could have been ten years ago. The Brazilian national department of health is continuing the fight against the disease in and about Pernambuco and Bahia, and has ample funds for the purpose.

Yellow Fever Commission to West Africa

In 1920 the Board sent a commission to West Africa to determine if possible whether yellow fever is present in that region, and if so, whether control measures would be feasible. The commission visited the Belgian Congo, Dahomey, Gold Coast, Northern Nigeria, Senegal, Sierra Leone, and Southern Nigeria; saw no case of yellow fever; conferred with medical authorities and examined many records; found strong indications of the presence of the infection within recent years; and recommended that a second commission be sent out prepared to stay, if necessary, for a period of two years for a more extended investigation—this to include a laboratory study of the suspected fevers of the region. The Board has approved. The fixing of the date of departure for this second commission must await the necessary arrangements with governments concerned, the special training of laboratory personnel, and the development of operations in other fields making possible the release of clinical specialists for the staff.

The Noguchi Vaccine and Serum

Killed cultures of *Leptospira icteroides* as a protective vaccine against yellow fever were first prepared and tested by Noguchi in Guayaquil in 1918. The use of the vaccine with laboratory animals had demonstrated its value in producing immunity. During the year 1920 it was used on a considerable scale on human subjects in Mexico and Central America, and the test was continued during the year 1921 in these countries and in Peru. The cumulative results of the two years' experience tend to confirm the earlier indications. To take a single striking example, Dr. Hanson vaccinated 200 non-immune soldiers in Lambayeque, Peru, and 200 civilians in Paijan. They went through a severe epidemic without a case among them. Continued tests of the therapeutic serum tend also to support the earlier results. When administered in the early stages of the disease it seems greatly to increase the chances of recovery.

II

Extending the Front against Malaria

Despite the economic depression which hit the Southern States with extreme severity, the fight against malaria has been maintained and steadily extended. A series of field experiments carried out in previous years had shown that malaria control in towns having a population of 1,000 or over and representing average conditions in these states is a paying investment. Effort was made during the year 1920 to drive this fact home throughout the more heavily infected region. By joint arrangement state departments of health, local communities, the United States

Public Health Service, and the International Health Board shared in carrying out demonstrations in fifty-two towns in ten states during 1920. In some communities control was effected mainly by the top minnow (*Gambusia affinis*). Malaria cases in these communities were reduced from 30 to 98 per cent at an average per capita cost of about seventy-eight cents. These results graphically exhibited were given wide publicity. The effect has been the creation of a sustaining and even aggressive public opinion which would seem to guarantee the permanency of the work.

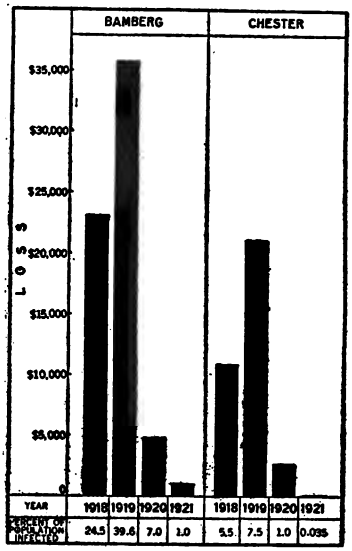


Fig. 9.—What malaria has cost the towns of Bamberg and Chester, South Carolina, during the years 1918 to 1921, inclusive, in the form of wages lost, doctors' bills, and medicines. Combined population, 7,768. Control measures instituted in both towns in 1920 have strikingly reduced this economic loss

During the year 1921 the service has been consolidated and extended. State and local funds have been increased. Malaria control is being made an integral part of the county health program and the states are assuming the responsibility for its central supervision. Six states—Alabama, Arkansas, Mississippi, Missouri, South Carolina, and Virginia—have provided central administrative budgets and are appointing specially trained personnel for the purpose. To meet the increasing demand for sanitary engineers and physicians who have had special training in this field, the Board has undertaken to maintain a considerable reserve corps through a period of apprenticeship. On completion of their training they are taken into federal, state, or county service.

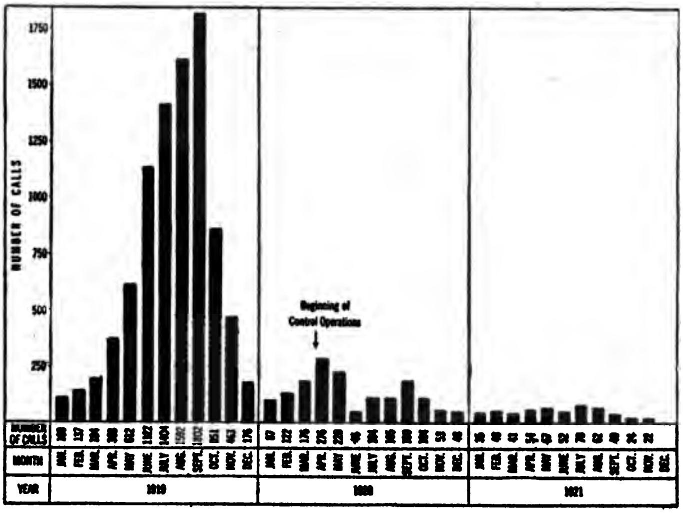


Fig. 10.—Reduction in physicians' calls for malaria in Groveton and South Groveton, Texas. Combined population, 2,500. Control operations beginning on April 1, 1920, strikingly checked the development of malaria cases during the remainder of 1920 and in 1921 kept the number of cases at a mere fraction of the number in 1919, which was typical of conditions in pre-control years

Intensive demonstrations have been undertaken during 1921 in twenty-six additional towns. In a number of communities—as in Texas for example—the municipal governments have provided the entire cost of the work save that of general supervision. For typical results see Figs. 9 and 10, pages 16 and 17.

Malaria Control on a County-Wide Scale

Field experiments in which the Board has shared hitherto have had for their object the testing of separate control measures: mosquito control in small towns; mosquito control in a typical rural community; quinine for sterilizing the blood of the infected; protection by the screening of houses. These nibbling efforts have served their purpose. During the year 1921 a major attack against malaria has been opened along the entire front, including town, village, and the open country. The unit of operations is the county. Malaria control is undertaken as a part of the permanent county health scheme; is supported by state, county, and local funds; and is under the direction of the county health officer.

All available measures are employed, each receiving emphasis according to local conditions. In Alabama, where an energetic sanitary engineer is co-operating with the health officers in a group

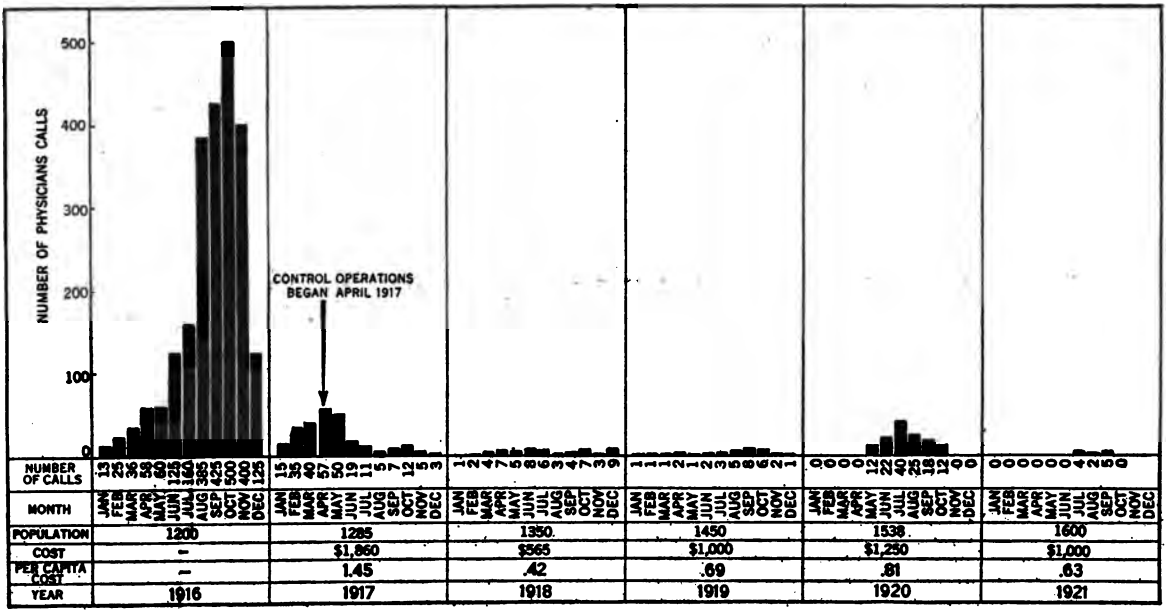


Fig. 11.—Record of malaria incidence for town of Hamburg, Arkansas, which has maintained anti-mosquito measures for five successive years. The work is now regarded as a regular municipal function. This town and Crossett, Arkansas, were the scenes of the International Health Board's first participation in malaria control by anti-mosquito measures

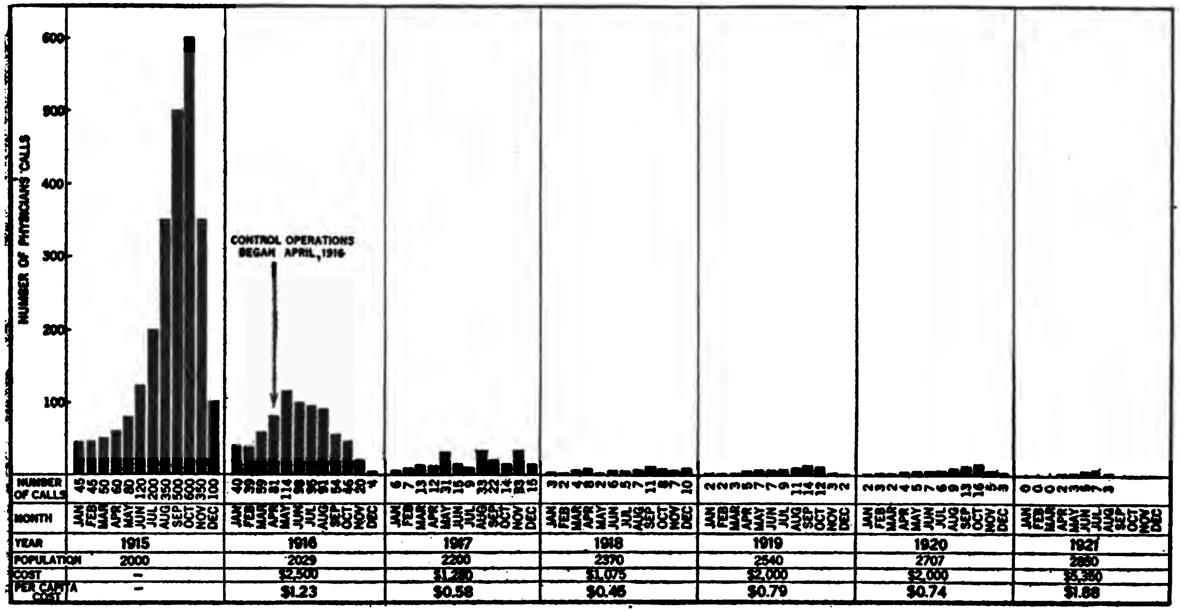


Fig. 12.—How malaria has been brought under control in Crossett, Arkansas. The anti-mosquito measures inaugurated in 1916 have been continued year by year, and in 1921 a system of concrete ditches and culverts was laid. The town is finding it much more economical to protect itself against malaria than to suffer the losses the disease involves

of five counties, mosquito control is being extended to rural communities. The top minnow —shown by Dr. Howard in his experiment in Mississippi to be effective and economical in controlling mosquito breeding about farm houses —is the principal agent here. The farmers are maintaining minnow ponds from which mosquito-breeding waters may be easily stocked with fish. In the Mississippi delta, on the other hand, where mosquito control is less feasible, anti-mosquito measures are not neglected where conditions favor, but greater emphasis is being placed on sterilizing quinine treatment. In all counties where the work has been undertaken the people are being taught to screen their houses as a protection against flies and mosquitoes. The standard quinine treatment for those who have malaria is provided at convenient points and its use is being stimulated by systematic education. This county-wide effort is being undertaken not as a brief intensive drive, but as a slow, steady campaign to be continued over a period of years.

Field Experiments in Malaria Control

A limited number of field experiments are being continued. As a result of Dr. Bass's work in Bolivar and Sunflower counties in Mississippi a standard quinine treatment for malaria in this region has become established and its use is being gradually extended to other counties and states. At Mound, Louisiana, tests are being carried out with a view to getting additional information on the screening of houses as a factor in malaria control; the effect of the location of houses, in relation to mosquito-breeding places, on the incidence and severity of malaria; effect of killing adult mosquitoes in homes; control of mosquito breeding by top minnows and wave action, in connection with impounding water in bayous and keeping down the marginal vegetation by pasturage. An experiment has been undertaken in Nicaragua to test the control of mosquitoes in a small town, under tropical conditions, by the simple and relatively inexpensive measures that have been successful in the Southern States. A similar test is being conducted in Porto Rico in an agricultural area.

III

Fighting Tuberculosis in France

The commission which the Board sent to France in 1917 to aid in organizing a national crusade against tuberculosis is well within sight of the end of its task. Responsibility is being rapidly transferred to French authorities. When the work began four years ago the French government and people were bearing the burdens of a devastating war and were carrying the additional

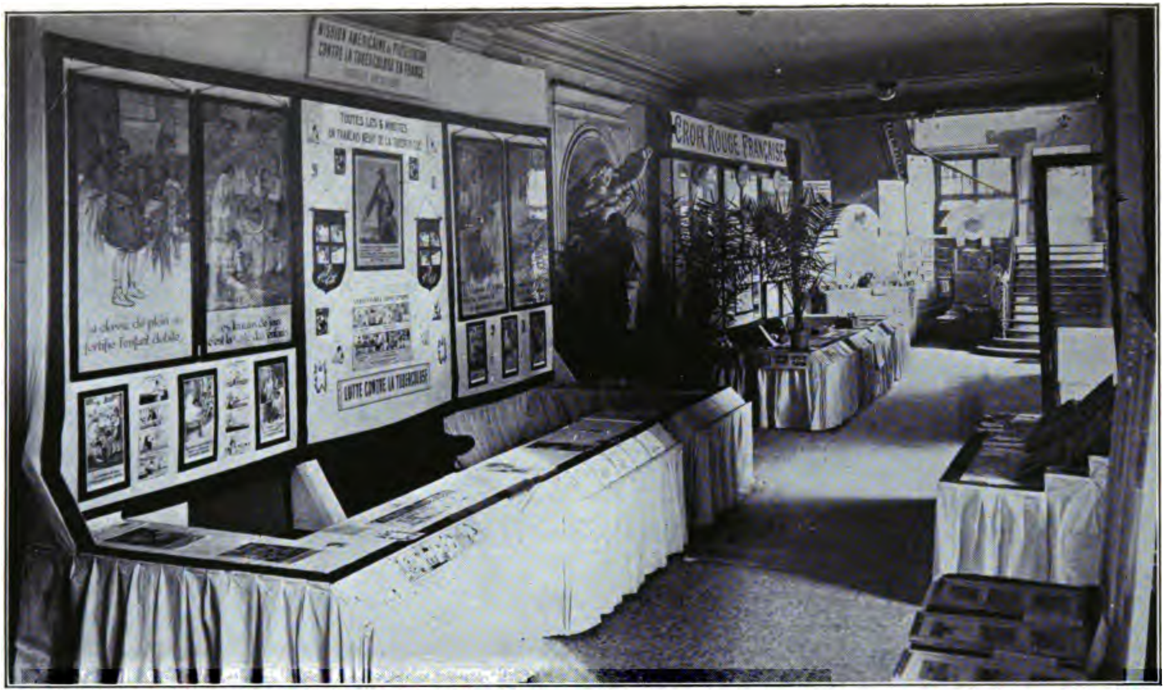


Fig. 13.—Tuberculosis exhibit at Pasteur Institute, Paris. Publicity measures are an essential feature of the campaign against tuberculosis in France

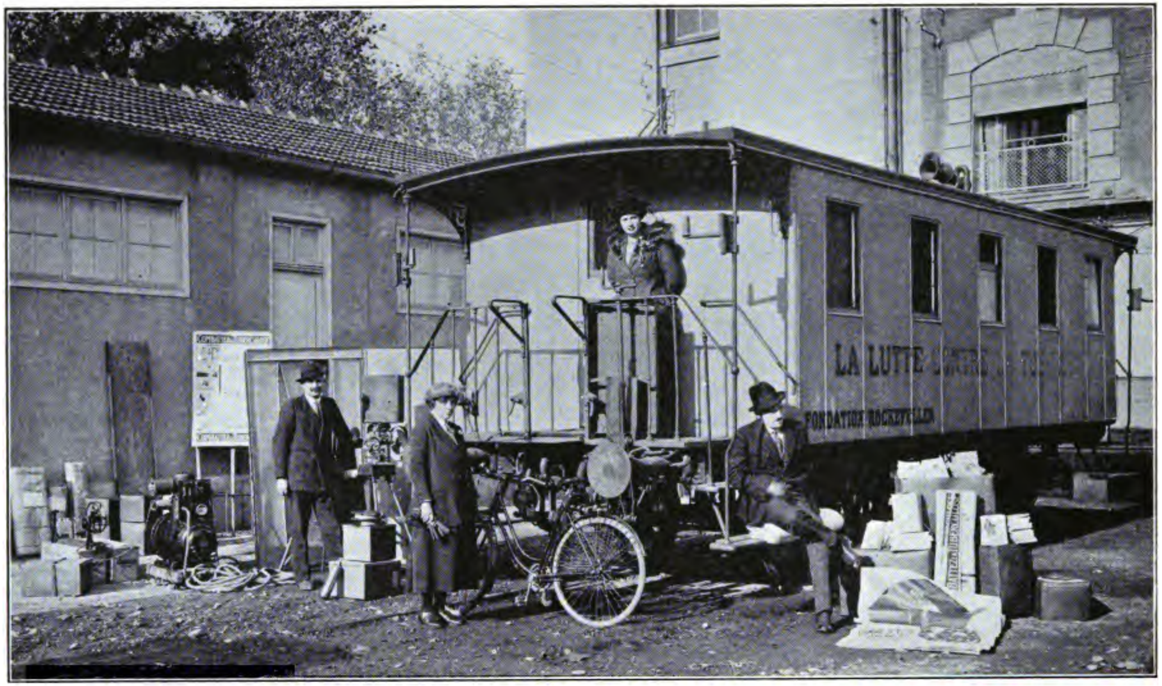


Fig. 14.—Traveling educational units have met with marked success in the anti-tuberculosis work in France. Motors cars and a special railway car have been used for transporting personnel and equipment. During 1921 fifteen departments were visited; 1,294 lectures were delivered to audiences aggregating 470,078; and a total of 3,594,500 pieces of literature were distributed

weight of a heavy tuberculosis rate which, as in all the warring countries, was supposed to be on the increase. There were in the country at that time but twenty-two tuberculosis dispensaries, and for persons needing hospital or sanatorium care not more than 8,000 beds.

To meet the situation a great multiplicity of agencies—French and American, official and non-official, military and civilian—pooled their interests in a spirit of team-play that made possible a coherent program. A scheme was projected on a national scale. It undertook to promote the establishment of tuberculosis dispensaries; to develop nursing schools for the training of public health visitors; to provide graduate courses for the training of doctors for the service; to establish a central records and statistical service; to conduct a nation-wide campaign of popular education; and in the end to stimulate the provision of hospital beds and sanatoria for the cases that need such care.

This united effort has met with enthusiastic response. The whole of France has been reached through the press and by literature in the schools. Mobile exhibits with teaching personnel have covered systematically fifty-four departments. In sixty-four departments the usual organization has been set up, providing for the operation of dispensaries and the maintenance of hospital beds. The national government is granting subventions for the building of sanatoria. Eight training schools for public health visitors are in operation; and of these, five seem to be on a permanent basis. Beginning with 1922 all but one are to offer a two-year course. Diplomas have been given to about 250 women who have completed the course and who are now serving, some of them as departmental supervisors, the others in local dispensaries. The graduate course in tuberculosis, which from the beginning awakened unexpected interest, has been completed by 264 dispensary physicians. All activities undertaken in 1917 may be regarded as rooted in French soil; they are being supported by Government and the people. The commission has been dissolved. Dr. Linsly R. Williams with a limited American staff represents the Board in completing the transfer of responsibility. Comradeship in this service to all who have shared it has been an inspiring privilege.

IV

Using the Hookworm in Promoting Public Health

Of the estimated seventeen hundred million people inhabiting the globe, something more than nine hundred million live in countries where hookworm infection is a serious menace to health and working efficiency. With increasing pressure for the development of tropical and subtropical lands the control of this disease—as of malaria and sleeping sickness—becomes a matter of serious international concern. Hookworm disease has been selected by the Board for special consideration, however, not primarily because of its relative importance as a disabling disease, great as that is, but rather because it lends itself readily to purposes of demonstration in disease control. It serves at once as an end in itself and as a convenient means to a larger end. The work, while bringing immediate relief to hundreds of thousands of suffering people, is at the same time serving the more useful purpose of creating a popular sentiment in support of permanent agencies for the promotion of the public health.

During the year the Board contributed toward demonstrations in hookworm control in forty-three states and countries throughout the infected zone; completed infection and sanitary surveys in the states of Alagoas and Espirito Santo, Brazil, in New Guinea, in the British Solomon Islands, in Tasmania, and in Queensland; and began surveys which are still in progress in New South Wales, in Western Australia, and in Northern Territory, Australia. Arrangements were entered into with Government for a series of demonstrations in Mauritius and Honduras. Re-infection surveys to determine results of previous work and to serve as a stimulus to further effort were carried out on a county-wide scale in forty-five counties in the Southern United States and in a number of smaller areas in Jamaica and Brazil.

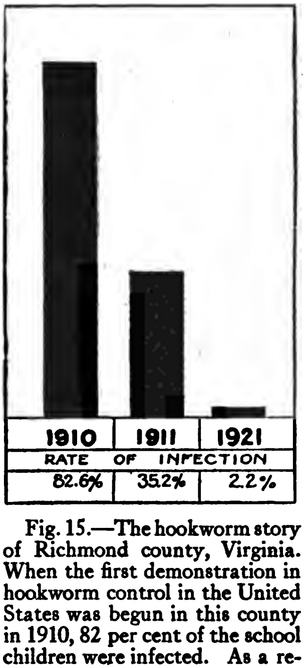


Fig. 15.—The hookworm story of Richmond county, Virginia. When the first demonstration in hookworm control in the United States was begun in this county in 1910, 82 per cent of the school children were infected. As a result of intensive treatment the infection was reduced in fifteen months to 35 per cent. Local agencies set in motion in 1910 have kept up the work until now hookworm infection in that county is negligible

The character of the work and the policy underlying its administration are well illustrated in

The First Field Demonstration

The first systematic effort to control hookworm disease in the United States was undertaken in 1910 in Richmond county, Virginia. It was under the direction of the Virginia State Board of Health, with the Rockefeller Sanitary Commission supplying the funds. An infection survey made in April of that year showed an average infection of 82.6 per cent among the school children. In one large section of the county the infection was found to involve practically the entire population and to be extremely severe. There followed an intensive effort to examine all the people; to treat those who were found infected; and by house-to-house visits to give them a definite understanding of the importance and the means of preventing soil pollution. Sanitary leagues were organized in local communities. Latrines were installed at all the schools and by persistent effort were gradually brought into use at nearly all the homes.

A second survey made in the summer of the following year showed that the infection among the school children had dropped from 82.6 to 35.2 per cent. Then the interesting thing happened. Outside aid was withdrawn; the county and its communities were left to their own devices. A third survey made ten years later—in the summer of 1921—showed that the infection among school children had dropped to 2.2 per cent. The first intensive demonstration in 1910, while reducing hookworm infection from 82.6 to 35.2 per cent, set in motion permanent local forces which within ten years have reduced the infection rate to the negligible fraction of 2.2 per cent (see Fig. 15, page 28).

And while conquering hookworm these same forces are conquering typhoid and dysentery as well. The recent survey referred to above showed that the people have latrines at their homes and are using them. Only two negro homes, two white tenant homes, and one white home owned by the occupant, were found without such protection. The late Dr. Fisher, who had been a practicing physician here for more than thirty-five years, stated that typhoid and dysentery used to bulk large in his practice. He had not had a case of either of these diseases for more than five years. He also reported—and the statement is abundantly supported by the facts as observed by the General Director, who visited the community in June, 1911, and again in November, 1921—that the economic and social changes which have come within this time are quite as great as the improvement in health.

Results in Eleven States

The service inaugurated in 1910 in Richmond county was extended rapidly to the more heavily infected counties of eleven southern states. Results similar in character—though less on the average in degree of control—have been accomplished throughout this infected region. Resurveys carried out on a county-wide scale, and based on the examination of school children—as were the original infection surveys of 1911–1914—have been completed in fifty-six counties; more than 29,000 children have been examined in these recent tests. The results show, for the fifty-two counties for which comparative records are now available, a decline in the average infection rate from 57.8 per cent in 1911–1914 to 27.7 per cent in 1920–1921. The change wrought in the physical appearance of the people is obvious even to the casual observer. As in Richmond county, so over the larger region, typhoid and dysentery also are being brought under control (see Fig. 16).

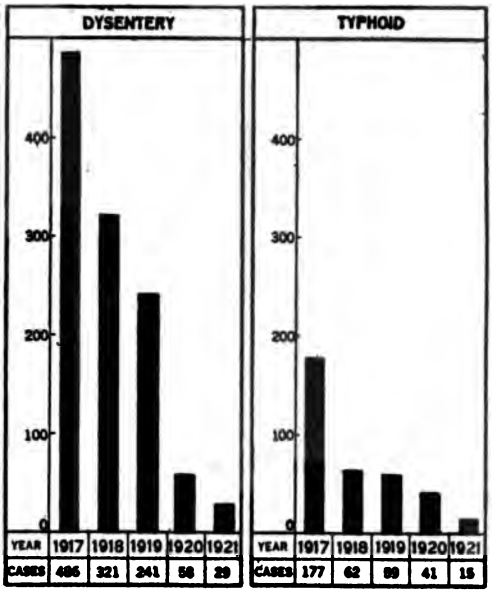


Fig. 16.—Decline in incidence of dysentery and typhoid fever, Troup county, Georgia, 1917–1921, inclusive. The prevention of soil contamination, brought about through the work of the county health departments, accomplishes not only the control of hookworm but of other soil-borne diseases as well

The point to be emphasized is that although the original intensive demonstrations in which nearly three fourths of a million people were treated in these states contributed to the immediate reduction of the infection both in degree and in prevalence, the results have been accomplished in the main by permanent local agencies rooted in the soil. These forces are continually active, are committed to the task, and may be depended upon to complete it.

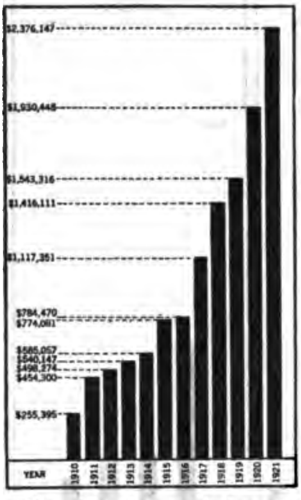


Fig. 17.—Appropriations of legislatures to state boards of health in eleven southern states 1910–1921. Includes funds for anti-tuberculosis work

Board's Work Completed

The object which the Board had in view has been accomplished. During the year the arrangement by which the Rockefeller Sanitary Commission and later the International Health Board had shared with the states in measures for the relief and control of hookworm disease was brought to a satisfactory close. Heads of health departments have seen develop in these states, in response to their efforts, a strong public sentiment in support of sound and aggressive public health policy. State legislative appropriations for health purposes have increased more than nine-fold during the eleven years (see Fig. 17, page 32). County health departments supported in the main by county funds have developed and are developing more rapidly than it has been possible to provide properly trained men (see Fig. 55, page 112).

Termination of the Board's participation in measures directed specifically to the control of hookworm disease does not disturb working relations with these states. It makes possible rather a transfer of funds to the further development of the more general county health program, to the fight against malaria, and to the training of personnel for the technical and administrative positions which are being created.

Testing Results in Brazil

With a view to testing the effectiveness of field operations in Brazil Dr. W. G. Smillie, Director of the Institute of Hygiene at São Paulo, made a resurvey during the year in two communities within the Federal area. The test was based on worm counts. Though the usual microscopic examination of stools showed but slight reduction in the percentage of persons infected in either of these communities, the number of parasites expelled showed a striking result. In one of the two communities where latrine construction had not been thorough the group that had been treated

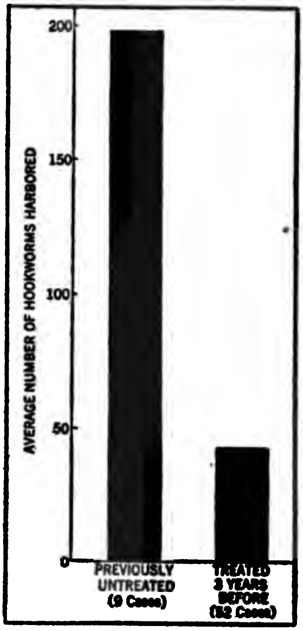


Fig. 18.—Control of hookworm disease as result of campaign measures applied in 1918 in Jacarepagua, Brazil. In that year the infected inhabitants harbored on an average approximately 200 worms; in 1921 they harbored only forty-two

at the time of the original demonstration harbored on the average forty-two parasites per person, while a group that had escaped treatment averaged approximately 200,—a reduction of 79 per cent. In the other community where latrine construction had been more thorough the test indicated that the original campaign, with

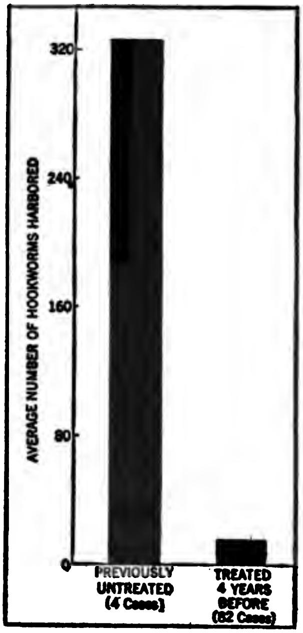


Fig. 19.—Reduction of hookworm disease as result of control measures, Governor's Island, Brazil. (In this graph and in Fig. 18 the cases represented by the bar "Previously Untreated" are few in number because the population of both places is largely transient. No considerable number of persons could be found in 1921 who had lived there and had not been treated at the time of the original campaigns in 1917–1918)

the continued operation of local forces, had within four years' time reduced by 95 per cent the number of hookworms harbored (see Figs. 18 and 19, page 34).[1]

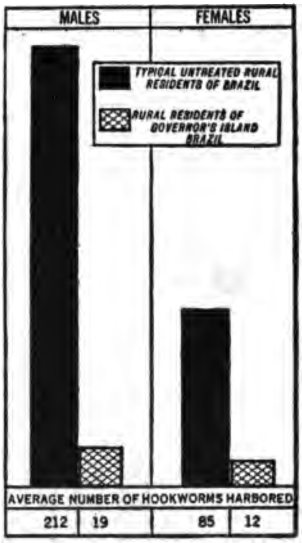


Fig. 20.—Effect of treatment and the installation of latrines on severity of hookworm infection. Worms harbored by typical untreated rural residents of Brazil compared with those harbored in 1921 by the rural residents of Governor's Island, who were treated three years previously

Transferring Responsibility to Brazilian Government

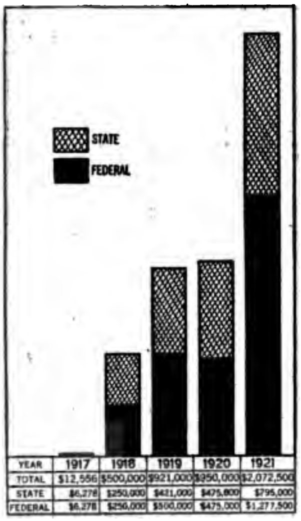
The work inaugurated in 1916 in the state of Rio and rapidly extended to the Federal area and eleven states is being taken over by government authorities as part of a permanent scheme of rural sanitation. For this purpose appropriations, state and federal, have increased from $12,556 in 1917 to $2,072,500 in 1921 (see Fig. 21, page 36). The Board is gradually transferring its funds from demonstrations in hookworm control to the development of a county health organization; the introduction of a public health nursing service;[2]

---

[1] For details, see The Results of Hookworm Disease Prophylaxis in Brazil, by Wilson G. Smillie. *The American Journal of Hygiene*, January, 1922, v. 2, No. 1, pp. 91-94. Same reprinted.

[2] See page 59.

field experiments in the fight against malaria; and the development of a school of public health.[1] An arrangement has been entered into—the state, the county, and the Board providing the funds—for the first demonstration of county health service in the state of São Paulo.



YEAR	1917	1918	1919	1920	1921
TOTAL	$12,556	$500,000	$921,000	$950,000	$2,072,500
STATE	$6,278	$250,000	$421,000	$475,800	$795,000
FEDERAL	$6,278	$250,000	$500,000	$475,000	$1,277,500

Fig. 21.—Increase in funds for rural sanitation appropriated by Federal and local governments in Brazil, 1917–1921

Progress in Permanent Sanitation in the West Indies

An illuminating field study carried out in Trinidad during the year by Cort and Payne[2] proved to be a striking demonstration of the effectiveness of the measures that are being carried out on a large scale in many lands, and particularly of the soundness of government policy in building up sanitary organizations to make the results permanent.

Governments are becoming increasingly active in Dutch Guiana, British Guiana, Trinidad, Porto Rico, and Jamaica, in providing funds, increasing their sanitary staffs, and in carrying out practical operations in the field. For the year 1921 Porto Rico appropriated $800,000 for public health purposes, including a tuberculosis sanatorium; set aside $30,000 of this—in addition to the necessary overhead—for the fight against hookworm disease; and with an efficient field staff under central direction established a creditable standard of soil sanitation in all areas of operation well in advance of the mobile clinics. The present field staff is to be the nucleus of a permanent system of inspection.

---

[1] See page 50.

[2] Summarized on pages 81 to 86.

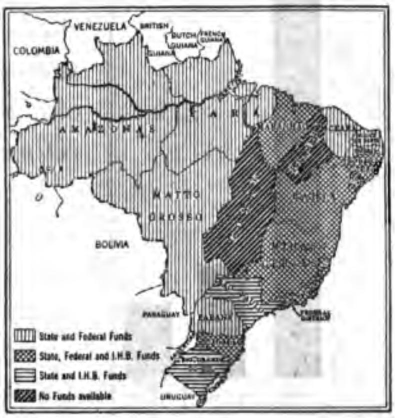
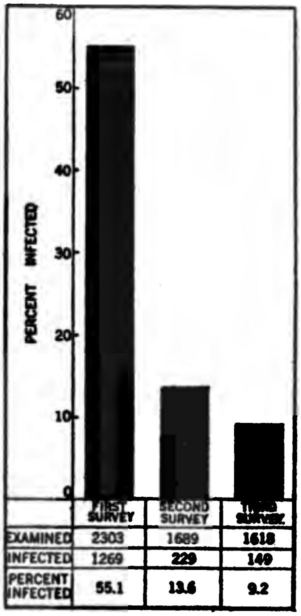


Fig. 22.—States of Brazil that have funds available for a program of rural sanitation. Most of the states are receiving Federal aid

In **Trinidad** Government has committed itself to the support of a general scheme of public health; has recently appointed one medical officer of health with provision for a second; has inaugurated a comprehensive plan of malaria control; is providing about $35,000 a year for the maintenance of its sanitary staff; has recently added to it three European inspectors; and has in progress an extensive program of latrine construction. In

Dutch Guiana, where only recently operations were resumed after enforced suspension during the war, Government is giving energetic support; has provided a staff of sanitary inspectors for Lower Surinam and Lower Pará; and with the hearty co-operation of the estates population is effecting a thoroughgoing reform in these regions.



	FIRST SURVEY	SECOND SURVEY	THIRD SURVEY
EXAMINED	2303	1689	1618
INFECTED	1269	229	149
PERCENT INFECTED	55.1	13.6	9.2

Fig. 23.—Reduction of hookworm infection rate on estates in the Vere area, Jamaica. First survey, November, 1919; second survey, May to October, 1920; third survey, August, 1921. The estate management is continuing systematic treatment and also installing latrines in an effort to stamp out the infection

In **Jamaica** the harassing—and at times apparently hopeless—inertia that early effort in the island had to face has yielded to a popular interest that is becoming increasingly general and aggressive. A striking demonstration in one community shows a fall in infection rate from 55 per cent in 1919 to 13 per cent in 1920, and to 9 per cent in 1921 (see Fig. 23). Areas of operation are now being sanitated in advance of treatment. A conference of parochial boards in December adopted a resolution approving the appointment of a superintending medical officer for the colony and a whole-time health officer in each of the parishes, with adequate field staff to establish a system of inspection. Government is preparing to expend $100,000 on sanitation during the year 1922.

Developing National Health Organization in Central America

In Central American countries—and particularly in Costa Rica, Nicaragua, and Salvador—measures undertaken in 1914 and 1915 against hookworm disease have passed successfully through the primary stage of field demonstration. Responsibility is being gradually transferred to government authorities, and control of the one disease is being merged into more general schemes of public health. In **Panama,** where development of local initiative has been stifled by the paternalistic policy of the Canal Zone, the formation of a responsible department of health is now being considered. Government is slowly developing a sanitary staff and is providing $12,500 a year for the work of the department of uncinariasis, or hookworm control.

In **Costa Rica** the service was formally taken over on May 28, 1921, as a division under the newly established national department of health, and the Board's representative was withdrawn. A limited contribution toward its maintenance is being continued through 1922, and provision has been made by means of fellowships for the training of additional men for the posts that are being created. In **Nicaragua** a commission appointed for the purpose by the President has drafted a sanitary code for the country and a law establishing a national department of health to carry it out. The Board is lending the services of a trained scientist to organize and direct a modest diagnostic laboratory, and is providing for the training of a limited number of native doctors for the new government service. The division of uncinariasis is to be the nucleus around which the new department is to be formed.

Salvador has had a national health organization for many years. During the year Government has reconstituted it in the interest of more aggressive action in the field. The new scheme correlates the various government medical services under central control; provides new and adequate quarters; reinforces the staff; creates a public health laboratory; takes over as one of its divisions uncinariasis control; and provides an annual budget of 170,000 colones, in addition to supplying 26,000 colones for the relief and control of hookworm disease and half the funds needed for the fight against yellow fever. The Board undertakes to aid in the training of additional men.

Promoting Public Health in the Far East

In the Far East the Board is sharing in a wide range of activities representing pretty well all stages of public health development. In **Borneo** the first demonstration in the control of hookworm opened with Government supplying a large part of the funds and the native population giving willing co-operation. In **Fiji**, where operations had been suspended during the war, adequate latrine accommodations were installed over a wide area preparatory to reopening the clinics early in 1922. Government is to assume entire responsibility at the end of three years. The infection survey of **Mauritius**—completed in 1920—led to an arrangement by which the Board is to share on a sliding scale for a period of three years in a series of demonstrations in control measures, leaving Government at the end of that time in full charge. In the meantime aid is being given in the training of local men. In **Madras Presidency, India,** where surveys made between 1915 and 1920 showed a rate of nearly 100 per cent among the laboring population, a scheme of practical operations for the Presidency has been approved, Government supplying all necessary funds save the salary and traveling expenses of the director. In the face of a sharp economic crisis in **Ceylon** operations are continuing, although on a diminished scale. A proposed revision of the sanitary law is indication of an interest in a more aggressive public health policy for the colony.

In **Siam** the National Red Cross is taking a leading part in the fight against hookworm disease. Government has enlisted the army, the navy, the gendarmerie, and the local chiefs. For more than a year the dispensaries have been treating on the average more than 1,000 persons per week; and an active propaganda has created a demand that the service be made national in scope. Plans are now under consideration for putting the medical school at Bangkok on a modern basis as a necessary first step toward the training of Siamese for public health work.

The five-year scheme entered into with **Australia** in 1918 is now being operated under the new Commonwealth Ministry of Health which was created last year. The services of Dr. W. A. Sawyer, the Board's representative, are being lent to the Ministry for a limited time; Dr. A. J. Lanza has gone out to organize a division of industrial hygiene; Mr. F. F. Longley is to set up a division of sanitary engineering; and Dr. F. F. Russell, of the Board's staff, is to make a brief visit toward the end of 1922 to aid

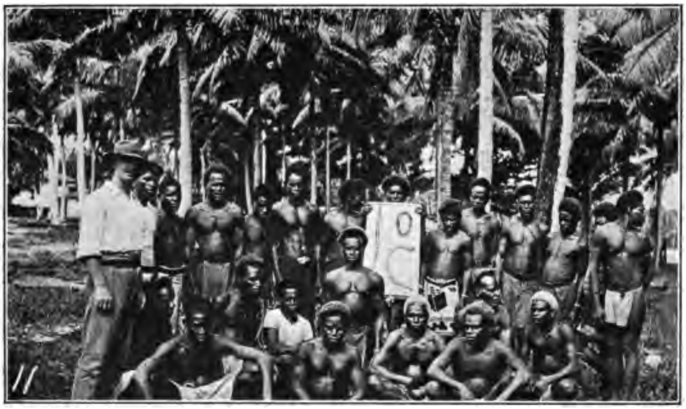


Fig. 24.—Carrying the gospel of sanitation to the natives of Solomon Islands. Plantation group assembled for lecture on hookworm disease at Rendova

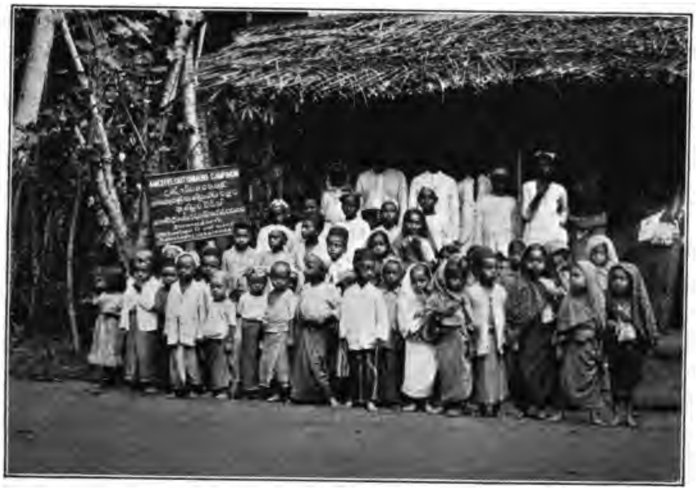


Fig. 25.—Group of Moors assembled at village dispensary to be treated for hookworm disease. After witnessing the results of five years' demonstration work among the Tamil estate population, large numbers of Moors are now voluntarily applying for treatment

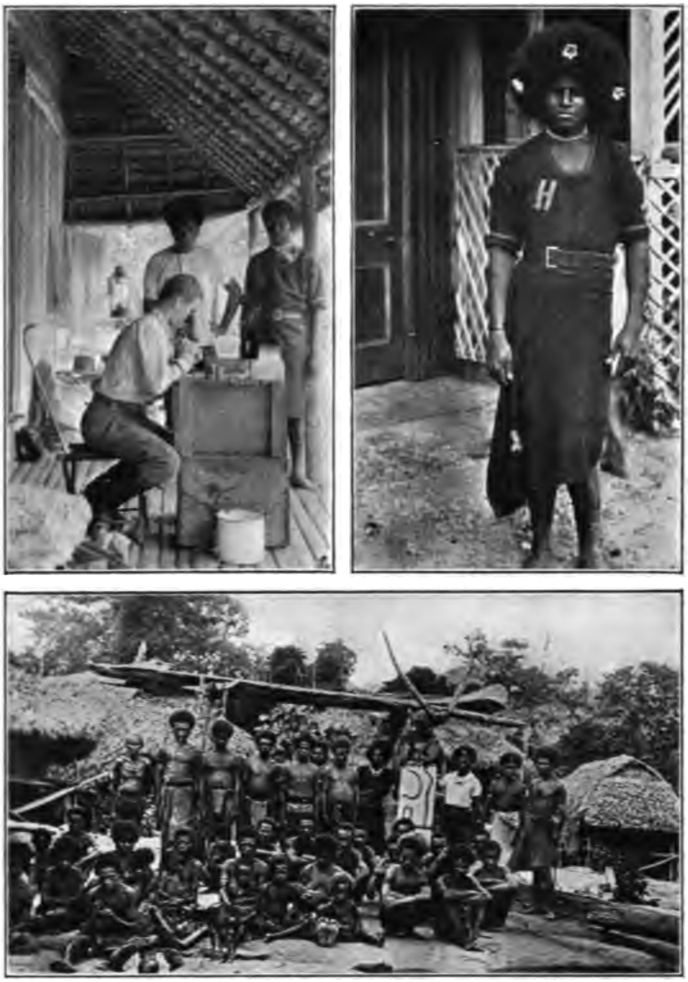


Fig. 26. Three phases of field operations against hookworm disease in Papua. *Upper left:* medical officer examining fecal specimen for hookworm eggs, Yule Island; *upper right:* native assistant in uniform of hookworm campaign staff; *below:* group of natives assembled to hear lecture, Sabuia

in the planning of a system of public health laboratories. In the meantime young Australians are being trained for these positions.

Just at the close of the year comes a call from the **Philippines.** In response to Government request the Board has undertaken to lend the services of Dr. Heiser, Director of its work for the East, for a period of three months; to provide a competent woman to aid in developing a public health nursing service for the Islands; to provide, for two years, a trained director for the public health laboratory in connection with the Bureau of Science; to detail a specialist to carry out a malaria survey; and to provide by means of fellowships for training a limited number of Filipinos in public health.

On Their Own Initiative

The year has brought reports of government and voluntary effort against hookworm disease in which the Board has not shared. Reference has been made in previous reports to the admirable work done in Assam under the direction of Colonel Sir Clayton Lane and to the eminent achievements of Schüffner and his colleagues in Sumatra. Paraguay took up the task two or three years ago; and now the Egyptian government is resuming operations which had been suspended during the war. Dr. Gann, Principal

Medical Officer of British Honduras, has completed a campaign extending over a period of three years and covering systematically the infected areas of the country. The infected have been treated; latrines have been provided, and the people have been taught to use them. It is now proposed to make the results permanent by a system of sanitary inspection. The report from British Honduras forces upon the reader the thought that if government medical officers everywhere had the public health point of view and something of Dr. Gann's aggressive energy, many of the cases of illness that are being treated in expensive hospitals would not occur.

Greater Speed and Economy in Field Operations

Results of the studies by Darling and Smillie in the administration of treatment for hookworm disease, and the more recent resurveys based on worm counts made by Smillie in Brazil, suggest important modifications in field procedures.

The findings of Smillie in Brazil and of Cort and Payne in Trinidad, for example, put beyond further question the value of mass treatment even when considered merely as a prophylactic measure. It is now known that by administering two standard doses of oil of chenopodium as a routine measure about 95 per cent of the parasites harbored by the people of a community may be expelled. To attempt to get rid of the remaining 5 per cent by following each case to a complete cure would double the cost. By leaving this small fraction of infection—which is not of great clinical importance—to be taken care of by sanitation, it has been found possible greatly to reduce the cost and increase the speed of field operations. A preliminary comparative test in Brazil indicates a saving by this modification of about 50 per cent in per capita cost.[1]

Field Studies in Hookworm Control

Reference has been made above to two or three studies that have been extremely fruitful in practical results. In this field 1921 has been the most productive year in the history of the Board. Colonel Sir Clayton Lane, with a small subvention, has been seeking to improve the technique of stool examination. Beta-naphthol has been given a further test as an anthelmintic on an extensive scale and under field conditions by Mhaskar and Kendrick in India. Ascaridol has been administered on a relatively small scale and with good results by Smillie in Brazil, Mhaskar[2] in India, and Molloy in Nicaragua. The administration of chenopodium without preliminary purge has been further tested under field conditions in Australia, Costa Rica, Panama, Salvador, and Colombia. The practice is becoming general. Dr. Washburn in Jamaica reports continued satisfactory results from the use of compound jalap powder. The most interesting contribution in the field of treatment is by Dr. M. C. Hall[1] of the Department of Agriculture, Washington, D. C., in administering carbon tetrachloride to dogs with 100 per cent efficiency for hookworms. The Willis salt-flotation method of stool examination has been tested on an extensive scale in the field and found to be efficient, rapid, and economical. Molloy of Nicaragua contributed an important improvement. Smillie finds that counting eggs on the slide as a means of estimating severity of infection, while serving as a rough indication when large groups are considered, is of small value in individual cases. Cort developed an improved apparatus for the recovery of hookworm larvae from the soil, and Smillie made an important contribution to the technique of differentiating hookworm and Strongyloides larvae. Dr. Caldwell, in Panama, completed a study of the relation of the action of sea-water on hookworm eggs and larvae to the extremely light infection among the San Blas Indians living by the sea.

---

[1] For details of working plan suggested by Dr. Smillie see pages 86 and 87 of this report; and Dr. Smillie's article "The Result of Hookworm Disease Prophylaxis in Brazil"; published in *The American Journal of Hygiene*, January, 1922 (v. 2, No. 1, p. 77–95).

[2] Working under the Indian Research Fund.

---

[1] No connection with Board's staff.

A small subvention by the Board made it possible for Dr. Cort, helminthologist in the Hopkins School of Hygiene, to go with a competent staff to Trinidad, British West Indies, for a series of field investigations covering a period of about four months. It proved to be an extremely fruitful expedition. The results, throwing much-needed light on practical control operations, are being published in the form of ten papers appearing serially in the American Journal of Hygiene.[1]

V

Developing Schools of Hygiene

In the autumn of 1913, soon after the beginning of operations on an international scale, the Board faced the fact that in order to carry out the activities it had undertaken it must have a staff of trained hygienists; and that the countries in which it was proposed to encourage public health development must also have such men. The men even for the Board's own staff were not then available. Institutions for their proper training—that is, institutions covering broadly the whole field of hygiene, and equipped to cultivate it as a science and to train men in its application as an art—had to be developed. The outcome was a direct contribution to the Johns Hopkins University to establish the Hopkins School of Hygiene and Public Health. The school, now in its fourth year, enrolled during the year 1920–1921, 122 students.

---

[1] For a more detailed summary of the field studies referred to in this section, see appendix, pages 81 to 92,

Since 1917 the Board has been contributing toward the development on a very modest scale of an institute of hygiene in connection with the medical school at São Paulo, Brazil. This institute gives an undergraduate course in hygiene to the students in the medical school; conducts short training courses for public health officers; carries out epidemiological field studies for the state; and has done an extremely creditable amount of productive scientific work. During the year the Board pledged about 27,000,000 crowns toward the establishment of an institute of hygiene at Prague. This institute, under the Ministry of Health and in close relation to the University Medical School, is to combine a central public health laboratory for Czechoslovakia with a school of instruction for public health workers. As a result of conferences between the officers of the Board and the authorities of Harvard University and its medical school during the early months of the year, plans were matured and approved by which the Rockefeller Foundation agreed to contribute the sum of $2,160,000 toward the further development of the Harvard School of Public Health. The resources now available are regarded as quite adequate for its immediate needs.

Fellowships in Hygiene and Public Health

In accordance with the policy illustrated in the foregoing section the Board contemplates contributing from time to time, as conditions may favor, toward the development of a limited number of schools of hygiene at strategic points throughout the world. As these institutions develop they will necessarily serve to stimulate and reinforce each other by interchange of experience, facilities, and men. The migration of students in the field of public health will then be feasible on a much more satisfactory scale than is possible under present conditions. In the meantime, however, the Board is taking advantage of the facilities now offered in England, the United States, and, by recent arrangement, in Canada, for the training of students from their own and other lands; and has provided by means of fellowships for a limited number of students to pursue courses in these countries. Fellowships have been granted to students who have been carefully selected with reference to their fitness for important posts as scientists, teachers, or practical administrators in the public health service, to which in most cases they have had definite assurance of appointment on completion of their courses. These fellowships are regarded as an investment in leadership. For the year 1921 fellowships were provided for fifty-four men and women from thirteen countries, as follows:

Brazil	5	Czechoslovakia	19	Nicaragua	2
Canada	2	France	4	Poland	3
Ceylon	1	Guatemala	1	Salvador	2
Colombia	1	Mexico	1	United States	11
Costa Rica	2				

Extension Courses in Public Health

The well-established schools of hygiene will give short courses for health officers. Under most favorable conditions, however, only a very limited number can be expected to attend these institutions. Each state will find it necessary to provide practical courses for the better training of its own workers. Modest beginnings in this direction are being made in the form of training centers of limited scope, correspondence courses, and institutes. During the year the Board has contributed toward institutes for health officers in Georgia, Ohio, Michigan, and Alabama; toward three institutes for public health nurses in New York state; and toward the organization of a correspondence course to be conducted by the Ohio department of health for full-time county health officers in that state.

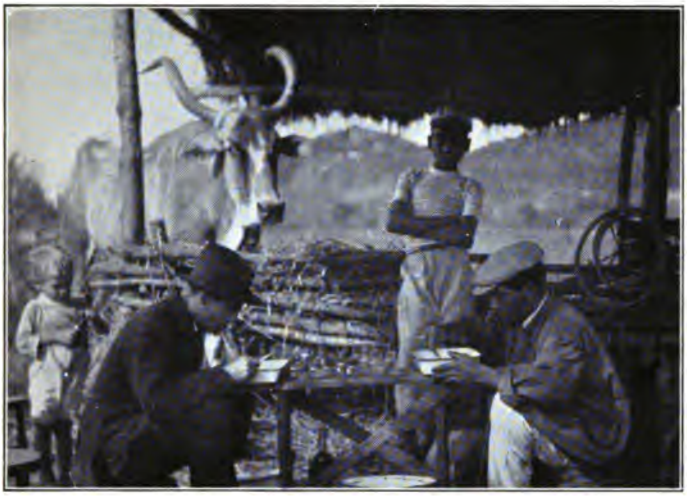


Fig. 27.—Counting hookworms expelled by treated patients. Field research conducted under the auspices of the Department of Hygiene of the São Paulo Medical School

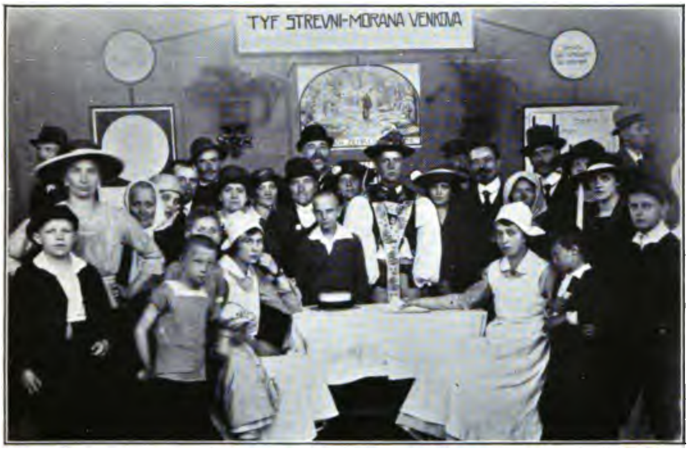
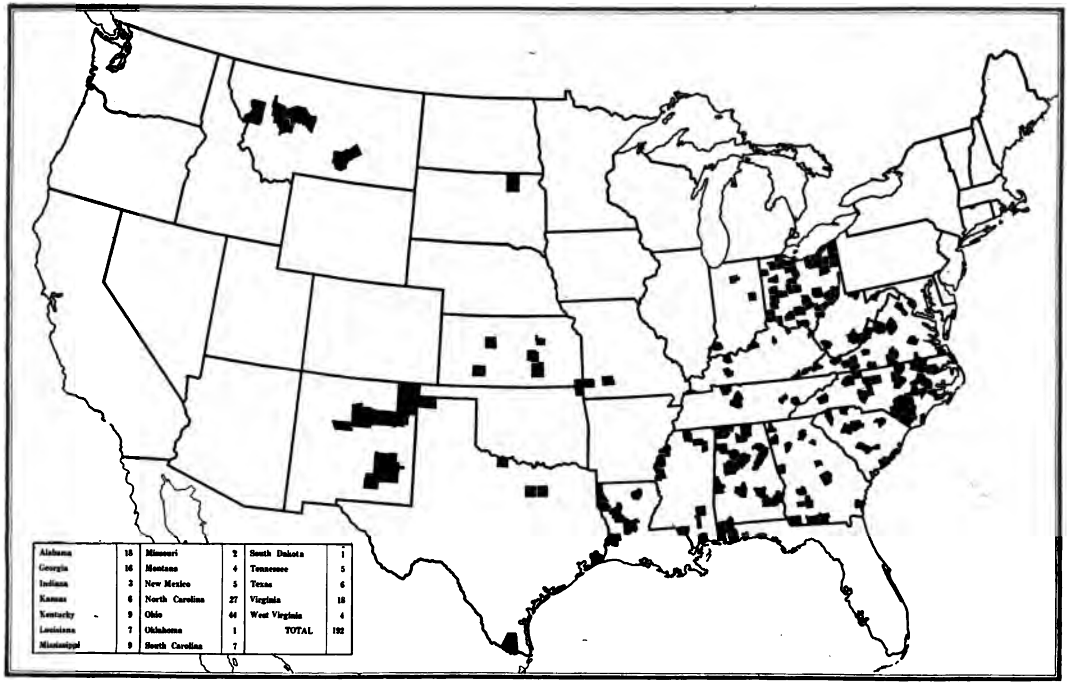


Fig. 28.—Group assembled at typhoid exhibit at Prague. One of the earliest activities of the newly organized Ministry of Health of Czechoslovakia, with which the International Health Board is co-operating, was an educational campaign against this disease



Alabama	18	Missouri	2	South Dakota	1
Georgia	16	Montana	4	Tennessee	5
Indiana	3	New Mexico	5	Texas	6
Kansas	6	North Carolina	27	Virginia	18
Kentucky	9	Ohio	44	West Virginia	4
Louisiana	7	Oklahoma	1	TOTAL	192
Mississippi	9	South Carolina	7		

Fig. 29.—Counties having full-time health officers at close of 1921

VI

Promoting County Health Work

For reasons which are well understood public health effort has been centered mainly on the larger towns and cities. Health protection for the people living in country districts has been neglected. The tide is turning. The development of county health organization—which is now going forward with considerable momentum in the United States—is providing a service for the smaller towns and rural communities.

In the Southern States county health administration developed naturally and inevitably from the effort to control hookworm disease. This is a rural disease; its control is a problem in rural sanitation; a serious effort to handle this one problem in rural sanitation called into being county organization. County organization once established, control of hookworm disease became merely an item in a general health program under state and county administration. The demonstration thus given of the value of the county as a unit in the state scheme stimulated a movement which is becoming general. At the close of the year county programs on a full-time basis were in operation in about 192 counties in the United States (see map, page 54).

The Board and the United States Public Health Service are aiding this movement by contributing toward a limited number of demonstrations. The average county health budget is about $10,000, and is provided from state and county funds. When the Board shares in a demonstration, it contributes toward a central budget or from $1,000 to $2,500 toward the county budget. During the year 1921 aid was thus given in sixteen states: Alabama, Florida, Georgia, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Mexico, North Carolina, South Carolina, Tennessee, Texas, Virginia, West Virginia. A similar demonstration is being carried out in Czechoslovakia and in the state of São Paulo, Brazil.

Experiment in County Health Administration

The county program, which is essentially a scheme of rural public health work, is, for the United States, a new undertaking. It invites critical study and experiment. A joint arrangement has been entered into by the Hopkins School of Hygiene, the Maryland State Department of Health, the United States Public Health Service, and the International Health Board by which such an attempt is to be made. The arrangement provides for a full-time service in a county easily accessible to Baltimore and under the immediate direction of a county health officer reporting to the head of the state service. Washington county has been selected for the purpose and is to contribute to the budget. The county is expected to serve as a field laboratory for the school, and to provide opportunity for investigation and for possible contribution to the development of a sound plan of health activities for rural communities. In so far as the undertaking succeeds it will serve as a demonstration and as a training base for students.

VII

Making Public Health Laboratories More Serviceable

A laboratory service — like vital statistics —is fundamental to intelligent public health administration. The trained health officer, however, understands that the provision of buildings, equipment, and scientifically trained men does not of itself provide the service he needs. Aggressive administration is equally necessary to make these facilities available to the people they are supposed to serve and to educate the doctors and people to use them. Under Dr. F. F. Russell, Director of Public Health Laboratory Service the Board has shared during the year in an increasing number of projects designed to promote this end.

Dr. Russell, while in Europe in connection with plans for the Institute of Hygiene at Prague, made brief visits for his own information to the public health laboratories at the three universities of Austria and some of the principal institutes of hygiene in France—at Nancy, Lyons, Montpellier, and Paris. These laboratories are doing a high order of technical work and are capable of doing a greater amount of it than is being required of them by the physicians of the regions they serve. Assistance was given in Alabama in adapting the state service to the larger opportunities opened up by a new and adequate laboratory building. Arrangement was made for the heads of the laboratory divisions in Alabama and Mississippi to visit the laboratories in other states and to observe the work of institutions where sera and vaccines are produced on a large scale. The state laboratories in Tennessee and West Virginia were visited for consultation regarding possible future developments. During the summer months Dr. Russell visited Panama, Central America, and Mexico. In Nicaragua arrangements were made for a diagnostic laboratory as part of the newly created national health service. In Salvador a national laboratory has been established under the department of health and is being organized by Dr. Segovia, who had been in training for this purpose on a fellowship granted by the Board. In Guatemala a first step in the direction of a diagnostic laboratory has been made by adding to the equipment and staff of the central laboratory used in the hookworm work. In Mexico Government has plans for a national institute of hygiene. Here the Board has served as agent for Government in finding a suitable American to direct the enterprise for a limited period.

VIII

Establishing a Public Health Nursing Service in Brazil

During the latter part of 1920 the federal health service of Brazil became a national department of health with greatly enlarged powers and resources. The new department, with Dr. Carlos Chagas as its distinguished head, has undertaken among other things a nationwide program in rural sanitation to be carried out by joint arrangement with the states; and for the Federal District is setting up new divisions for child welfare, venereal disease control, and a crusade against tuberculosis. These activities have made acute the need of trained public health nurses. To meet the situation Government is establishing a training school in Rio de Janeiro. The Board has undertaken to assist in securing a competent corps of American nurses to operate the field dispensaries and the training school for a period of three years. In the meantime a selected group of Brazilian women are to be trained with a view to taking over the responsibility. A limited number of dispensaries are in operation and plans have been completed for opening the training school early in the coming year. Arrangements have been made for recruiting the student nurses from the best graduates of the normal schools.

IX

Laying Foundations in Czechoslovakia

The Ministry of Health in Czechoslovakia, confronted with the task of creating a new service for the country, is showing great wisdom in undertaking the training of a staff of selected young men to develop and administer it. In accordance with plans matured in Prague in February, 1920, and approved by the International Health Board the following May, provision was made for a commission representing the Ministry to study public health administration in England and the United States. After the return of the commission early in the year 1921 the Ministry set up a committee to undertake a critical revision of its own plans and procedures. In the general scheme which is being put into operation first consideration is being given to a few fundamentals: (1) a reporting and statistical service that shall provide the information which the Ministry and local health officers need for their daily guidance; (2) a public health laboratory service that shall make its facilities available to all the people of the country; (3) effective control of the ordinary communicable diseases; (4) provision of wholesome water supplies; (5) protection against contaminated milk; and (6) an institution for the adequate training of personnel. The Board at its meeting in May appropriated approximately 27,000,000 crowns toward the buildings and equipment of an institute of public health at Prague; and provided by means of fellowships for the training of twenty-two young Czechoslovaks for staff positions in this institute and for the administrative services outlined above.

Publications

During the year 1921 the following reports and publications were issued by the International Health Board:

Annual Report for the Year 1920.

Infant Mortality in New York City. By Ernst Christopher Meyer, Ph.D.

Staff members and others directly associated with projects in which the Board participated made the following contributions to medical and public health literature, most of them in the form of articles published in medical journals that are widely circulated among persons interested in medical and public health topics:

Bass, C. C.

Diagnosis of the commoner intestinal parasitic infections. *Southern Medical Journal*, Nov., 1921, v. 14, p. 863–865.

Standard treatment for malaria. *Public Health Reports*, July 1, 1921, v. 36, p. 1502–1504.

The standard treatment for malaria—a discussion of some of its advantages. *Southern Medical Journal*, Apr., 1921, v. 14, p. 280–288.

Connor, M. E.

Fish as mosquito destroyers; an account of the part they played in the control of yellow fever at Guayaquil, Ecuador. *Natural History*, 1921, v. 21, p. 279–281. Same reprinted.

Cort, W. W.

Investigations on the control of hookworm disease; general introduction. *American Journal of Hygiene*, Sept.–Nov., 1921, v. 1, p. 557–568.

Cort, W. W., D. L. Augustine, and G. C. Payne

Investigation on the activities of infective hookworm larvae in the soil; preliminary report. *Journal of the American Medical Association*, Dec. 24, 1921, v. 77, p. 2035–2036.

Darling, S. T.

The tertian characters of quotidian aestivo-autumnal fever. *American Journal of Tropical Medicine*, Nov., 1921, v. 1, p. 397–408.

Darling, S. T. and W. G. Smillie

Studies on hookworm infection in Brazil; first paper. N. Y., Rockefeller Institute for Medical Research, 1921. (Monograph no. 14.)

Technic of chenopodium administration in hookworm disease. *Journal of the American Medical Association*, Feb. 12, 1921, v. 76, p. 419–420. Same reprinted.

Ferrell, J. A.

Careers in public health service. *Journal of the American Medical Association*, Feb. 19, 1921, v. 76, p. 489–492. Same reprinted.

Measures for increasing the supply of competent health officers. *Journal of the American Medical Association*, Aug. 13, 1921, v. 77, p. 513–516. Same reprinted.

GREGG, ALAN

Inspeccão sanitaria da Commissão Rockefeller no estado do Paraná. *Archivos paraenses de Medicina,* Curityba, Jan., 1921, v. 1, p. 273–276.

Inspecçãe sanitaria da Commissão Rockefeller em Santa Catharina. *Archivos paraenses de Medicina,* Curityba, May, 1921, v. 2, p. 11–16.

GUITERAS, JUAN

Observations on yellow fever in a recent visit to Africa. *Sanidad y Beneficencia,* Habana, Jan.–Mar., 1921, v. 25, p. 34–43.

HACKETT, L. W.

Os cinco annos da Commissão Rockefeller no Brasil. *Boletim da Academia Nacional de Medicina,* Rio de Janeiro, 1921, v. 93, p. 62–73.

HARRISON, A. P.

Oil field sanitation. *Texas Municipalities,* Sept.–Nov., 1921, v. 8, p. 108–111.

HEGNER, R. W. AND G. C. PAYNE

Surveys of the intestinal protozoa of man in health and disease. *Scientific Monthly,* Jan., 1921, p. 47–52. Same reprinted.

LAMBERT, S. M.

Intestinal parasites in North Queensland. *Medical Journal of Australia,* Apr. 23, 1921, p. 332–335. Same reprinted.

LEPRINCE, J. A.

Co-operative anti-malaria campaigns in the United States in 1920. *Southern Medical Journal,* Apr., 1921, v. 14, p. 297–306.

NOGUCHI, HIDEYO

Prophylaxis and serum therapy of yellow fever. *Journal of the American Medical Association,* July 16, 1921, v. 77, p. 181–185.

Recent experimental studies on yellow fever. *American Journal of Hygiene,* Jan., 1921, v. 1, p. 118–129. Same reprinted.

NOGUCHI, HIDEYO AND I. J. KLIGLER

Experimental studies on yellow fever in northern Peru. *Journal of Experimental Medicine,* Feb. 1, 1921, v. 33, p. 239–252. Same reprinted.

Immunology of the Peruvian strains of *Leptospira icteroides. Journal of Experimental Medicine,* Feb. 1, 1921, v. 33, p. 253–260. Same reprinted.

NOGUCHI, HIDEYO AND WENCESLAO PAREJA

Prophylactic inoculation against yellow fever. *Journal of the American Medical Association,* Jan. 8, 1921, v. 76, p. 96–99.

SAWYER, W. A.

Hookworm in Australia. *Medical Journal of Australia,* Feb. 19, 1921, p. 148–150. Same reprinted.

Team work in sanitation. *Medical Journal of Australia,* Apr. 9, 1921, p. 285–287. Same reprinted.

SEDGWICK, W. T.
Modern medicine and the public health. *Public Health Reports*, Jan. 28, 1921, v. 36, p. 109–116.

SMILLIE, W. G.
Comparison of the number of hookworm ova in the stool with the actual number of hookworms harbored in the individual. *American Journal of Tropical Medicine*, Nov., 1921, v. 1, p. 389–395.

SOUZA, G. H. DE PAULA
Sanitary propaganda in Brazil. *Bulletin of the Pan American Union*, Apr., 1921, v. 52, p. 364–366.

STUART, EDWARD
Popular health instruction. *International Journal of Public Health*, Mar.–Apr., 1921, v. 2, p. 152–163.

VAN DINE, D. L.
The destruction of anopheles in screened dwellings. *Southern Medical Journal*, Apr., 1921, v. 14, p. 289–296.

VINCENT, G. E.
Passing of the country doctor. *Forum*, Oct., 1921. Reprinted with the title, Modern tendencies in medical education and practice.

World health and the Rockefeller Foundation. *Nation's Health*, May, 1921, v. 3, p. 270–272.

WARREN, A. J.
General outline of a comprehensive plan of rural health work. *Kansas State Board of Health, Bulletin*, May, 1921, v. 17, p. 84–87.

WILLIAMS, L. R.
Some problems of nursing education. *New York State Department of Health, Health News*, Sept., 1921, v. 16, p. 189–197.

WILLIS, H. H.
Simple levitation method for the detection of hookworm ova. *Medical Journal of Australia*, Oct. 29, 1921, p. 375–376. Same reprinted.

WYATT, B. L.
Review of the work of the medical bureau of the Commission for Prevention of Tuberculosis in France, July 9, 1917—Dec. 30, 1920. Paris, 1921.

APPENDIX

ACKNOWLEDGMENT

Extensive use has been made of the following special articles and reports in compiling the appendix, particularly the sections dealing with hookworm disease and malaria:

"Investigations on the control of hookworm disease," by W. W. Cort, D. L. Augustine, J. E. Ackert, F. K. Payne, and G. C. Payne. *The American Journal of Hygiene*, Baltimore, September–November, 1921, v. 1, Nos. 5 and 6; January, 1922, v. 2, No. 1; March, 1922, v. 2, No. 2.

"Anti-Hookworm Campaigns in Southern India," by J. F. Caius, K. S. Mhaskar, and J. F. Kendrick. In manuscript.

"Report Covering Experiments in Malaria Control," by C. C. Bass. In manuscript.

In certain instances the authors' own words have been used. The Board is indebted to these as well as to many other members of the staff for contributions in the form of reports and articles which have made possible the following statement of findings and results.

APPENDIX

I

EXTENT AND SEVERITY OF HOOKWORM DISEASE

INVESTIGATIONS IN INDIA

Early in 1915 the Indian Research Fund Association decided to devote a share of its attention to the subject of hookworm infection in India. Its first inquiry, under the auspices of Colonel Sir Clayton Lane, was carried out in the tea gardens of the Darjeeling district during the winter months of 1915 and 1916. Later, or from October, 1916, to March, 1917, a similar inquiry was conducted among the coolies collected at the emigration depot at Negapatam. In April, 1917, the locale of the investigation was transferred to Dindigul (see map, page 68), and additional work was undertaken in Trichinopoly jail. The work in Dindigul was closed on May 24, 1919, and the staff moved to Trichinopoly, where, until December, 1921, they continued to devote themselves exclusively to investigations into the prevalence and severity of hookworm infection and the factors necessary for its control.

Inauguration of Control Operations. The early investigations having satisfied the authorities of Madras that the infection brought about much physical suffering and economic loss within the Presidency, Government determined to carry out an active campaign against the disease. Upon invitation the Board lent medical officers, in the beginning Dr. George P. Paul and later Dr. John F. Kendrick, to assist in the work, and on April 7, 1920, control operations were undertaken at the Cannanore jail. This piece of work was completed on June 26, 1920, and the following month examination and treatment were begun among the labor forces on the Wynaad-Nilgiri tea estates. Effort continued here until November 15, 1920, when control measures were inaugurated among the employes of the Buckingham and Carnatic mills in the city of Madras. In June, 1921, the staffs of Madras and Trichinopoly joined hands and carried out two experimental campaigns among coolies of the Mudis and Kalyanapandal tea estates in the Coimbatore district.

Prevalence of Infection in Madras Presidency. From the inception of the work in Negapatam in 1916 until the close of the year 1921, a total of 19,239 persons were examined: 16,743 in villages, towns, and rural areas, and on estates; and 2,496 in the city of Madras. In the areas exclusive of Madras city, 97.1 per cent of all persons examined were found to harbor hookworms; in Madras city, 63.6 per cent. Conditions extremely suitable for the development of the parasites and the spread of the disease were encountered practically everywhere: the country is tropical, and the vast majority of its inhabitants go barefoot, live away from sewerage, and work in the soil.

Severity of Infection in Madras Presidency. Although the investigations indicated that nearly everyone in the Presidency was infected, all classes and all walks of life were not infected to the same degree. Sweepers, or town scavengers, and ryots working in close contact with the soil were found to harbor six times as many worms as the police, and twelve times as many as the classes who spend most of their time indoors. Among most classes the infection seldom produces severe symptoms, as the parasites are relatively few in number and nearly always the less harmful Necators. It is chiefly to estate laborers that the infection brings an appreciable diminution in health and energy. Since, however, the laboring classes, which are most severely infected, make up the bulk of the population, the country must suffer in the aggregate an enormous economic loss from the effects of the disease.

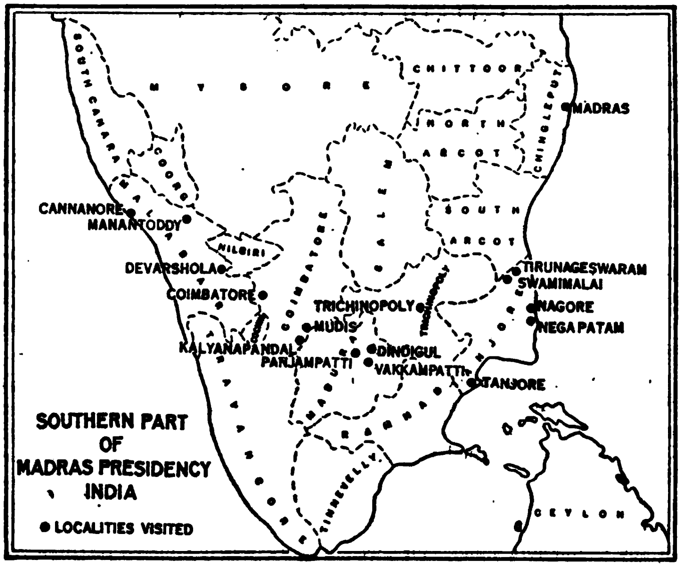


Fig. 30.—Localities visited in investigation into the incidence and effects of hookworm disease in Madras Presidency, India

The following paragraphs give a brief résumé of the findings in the different localities investigated:

a. Inquiry at Negapatam. Of the total of 8,969 persons examined in the investigations conducted at Negapatam, 98.6 per cent of the coolies in the emigration depot were found infected and 91.0 per cent of the people in the town. Since the coolies examined were drawn from thirteen districts and four states of the Madras Presidency, and since the infection was found as often among those who had never before left the country as among those who were emigrating for the second or third time, the results demonstrated hookworm disease to be endemic in India. They suggested also that the infection was universally prevalent in rural areas of the Trichinopoly, Tanjore, Malabar, Madura, and South Arcot districts (see map, Fig. 30, page 68).

The infection occurred in all classes of people examined, irrespective of locality, caste, age, sex, or occupation, yet it was noted that ova were found more readily in specimens from the depot and village population than in those from residents of the town. Sixty-two per cent of the coolies examined at the depot, practically all of whom harbored hookworms but who nevertheless constituted a selected group, were in apparent good health and an additional 35 per cent in fair health. Not more than 3 per cent were visibly affected. Among the children of the town, however, the presence of hookworm infection was unquestionably responsible for much ill health, anemia, and retardation of physical development.

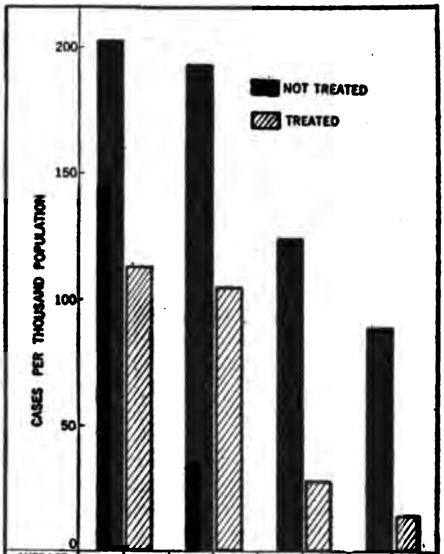
b. Swamimalai-Tirunageswaram. These two typical villages in the Tanjore district were selected for investigation in the hope of gaining some insight into the incidence of the infection among the village population of India. All of the 239 persons examined in the two towns were found infected, irrespective of sex, age, or apparent state of health. The physical condition of the coolie population as a whole was poorer than that at Negapatam. Again the school children showed marked debility and general retardation.

c. Dindigul. Dindigul town and the few neighboring villages were next chosen for observation. Of 412 persons microscopically examined, including sweepers, police constables, factory hands, school children, and patients in hospital, 100 per cent were found infected. Seventy-nine sweepers harbored an average of 127 worms per case; fifty-two police, an average of twenty-one; twenty-one persons of the upper and middle classes, an average of eleven. On the whole the infection was light; in the main the worms were of the species Necator.

d. Vakkampatti-Panjampatti. Examination of 250 fecal specimens in these two villages, located five miles from Dindigul, again showed 100 per cent infection of a degree that, though still mild, was decidedly heavier than in the town.

e. Trichinopoly jail. Of convicts who had resided in the southern part of Madras Presidency, ninety-seven of every 100 examined were found infected. The severity of the infection varied widely according to districts, the average number of worms harbored ranging from 6.2 to 102.8. For ten selected districts the average complement of worms harbored was sixty-two. Here again the worms were mainly of the species Necator.

No clear relationship was discovered between the hemoglobin index and the number of hookworms harbored, and no justification for classification into light, mild, and severe cases on the basis of degree of anemia. Treatment which resulted in complete elimination of the parasites raised the hemoglobin index only two-tenths of a point, or from an average of 74.6 to 74.8. It was, however, shown fairly conclusively that freedom from hookworm disease diminished the susceptibility to bowel complaints and influenza, shortened the period of illness from these diseases, and lowered the death rate (see Fig. 31). There was, moreover, in the matter of gain in weight, a slight difference in favor of treated cases, 72.2 per cent of them showing a gain as compared with 66.3 per cent of untreated cases.



	1918		1919		1920		1921	
AVERAGE POPULATION	550	553	724	654	522	682	452	936
TOTAL CASES	112	64	140	69	65	19	40	13
TOTAL DEATHS	10	5	8	0	1	0	0	0
AVERAGE DURATION OF ILLNESS DAYS	14.1	15.6	15.1	10.7	14.2	9.2	14.8	9.4
YEAR	1918		1919		1920		1921 -	

Fig. 31.—Incidence of bowel complaints, Trichinopoly jail, India, 1918 to 1921, inclusive. Among prisoners who had *not* been treated for hookworm disease, sickness and deaths from bowel complaints were much more frequent than among those who had been treated

Study of the records for 1,878 prisoners brought out the interesting fact that while the *incidence* of hookworm infection is not appreciably affected by jail life even under sanitary conditions, a natural progressive elimination of worms takes place that does very markedly affect the *intensity* of the disease. Thus, an average infection of fifty-eight worms on admission fell to forty-eight among inmates of a month and to thirty-two, twenty-nine, and seventeen worms, respectively, among inmates of three, twelve, and eighteen months. After eighteen months the average number of hookworms per case, though low, remained nevertheless fairly constant, even so long a stay as seventeen years failing to bring elimination of all the worms.

f. Coimbatore jail. During an interval in the work in Trichinopoly jail brought about by an epidemic of cholera, the stools of 463 prisoners in the Coimbatore jail were examined for hookworm ova and the hemoglobin indices determined in 300 cases. The rate of hookworm infection was 87.5 per cent; the average hemoglobin index, 72.4. The few figures collected showed again that a prolonged stay under the sanitary regimen of jail life brought down the intensity of hookworm infection but in no case eliminated it. There was no opportunity, however, as at Trichinopoly, for investigating the effect of treatment in improving the physical condition of the convicts.

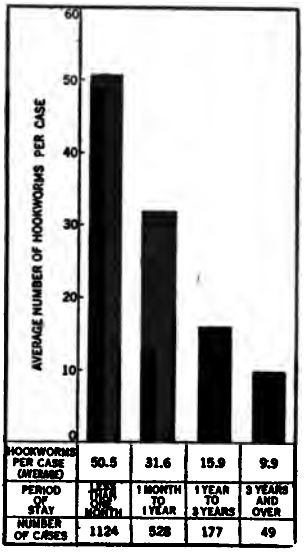


Fig. 32.—Worms harbored by 1,878 prisoners examined in Trichinopoly jail, India, grouped according to length of stay in jail. Natural progressive elimination of worms takes place as the period of jail residence lengthens, the opportunities for acquiring additional heavy infection being limited

g. Cannanore jail. Microscopic examination of the 964 inmates of Cannanore jail, drawn mostly from the wet districts of Malabar and South Canara, revealed a rate of infection of 89.7 per cent. The incidence among new arrivals is probably nearer 99 per cent, for examination of 197 specimens obtained from persons lately admitted to the jail showed ova in 196, or 99.5 per cent. Only a few cases presented clinical manifestations of severe or even moderately severe hookworm infection. The large number of infected convicts were freed of their worms in a short time by a small staff administering systematic treatment.

h. Manantoddy-Devarshola. On these estates examination of about 2,300 coolies gathered from diverse parts of the Presidency showed 100 per cent hookworm infection among coolies from wet districts and 83 per cent among those from dry. Hemoglobin estimations made on 200 of the coolies revealed an index of 60.0. Most of these estate coolies were in pitiful physical condition.

i. City of Madras. Among 1,782 persons examined at the Carnatic mills in the city of Madras, the general rate of infection was 64.5 per cent. Among clerical workers it was only 18.4 per cent. Of 609 persons examined at the joint school of the Buckingham and Carnatic Mills, the teachers, who wear shoes, were 15.8 per cent infected, and the pupils, who go barefoot, 55.7. In the Chingleput town reformatory 88.6 per cent of the 245 persons examined were found infected.

Signs of severe hookworm disease were seldom seen at the mills; only seventeen cases of profound anemia were observed, and these improved rapidly under treatment. Sanitary latrines, provided in sufficient numbers and in convenient places at the mills, are unquestionably a factor in keeping down the infection. Elsewhere in the city of Madras gross soil pollution occurs, especially around the huts and tenements. In a section of the city containing several hundred one-room tenements, inspection disclosed only one latrine.

j. Mudis tea estates. On this group of five tea estates, located seventy miles south of Coimbatore, microscopic examination of 794 coolies, for the most part recruited from the plains of Madras Presidency, revealed 91.6 per cent infected; examination by treatment and recovery of worms revealed 100 per cent infected. The number of worms harbored by seventy-four coolies whose worms were saved after treatment ranged by provinces from 21.5 to 205.7 per person, an average of 92.9 (see Fig. 35, page 76). Hemoglobin estimates on 1,558 coolies revealed an average index of 74.8, with 10 per cent of the cases lower than 50. Here again no correlation was found between the hemoglobin index and the number of hookworms harbored.

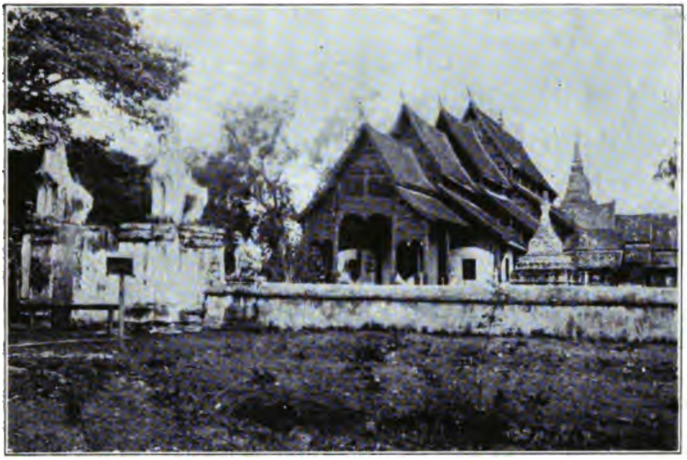
INCIDENCE IN AUSTRALIAN TERRITORY

By the end of the year 1921 all of the projects contemplated in the original plan for the control of hookworm disease in Australia, embracing surveys or control operations in every Australian state and in the three territories, were under way. Surveys were completed during 1920 or 1921 in Tasmania, in New South Wales, in Victoria, in the British Solomon Islands adjacent to Papua, and in additional areas in the state of Queensland. Results to date indicate that Western Australia as well as an area in Northern Territory centering in Darwin is entirely free of hookworm infection.

Victoria and Tasmania. In the survey of the state of Victoria no hookworms were found among the 1,629 persons examined. The mines were as free of infection as the surface, where climatic conditions, particularly lack of rain, are unfavorable to the development of larvae. In Tasmania 2,209 fecal examinations revealed only two cases of hookworm infection, both in persons who had arrived from Fiji during the preceding seven months. The general climatic conditions of this state also are considered unfavorable to the development of hookworm larvae.

State of Queensland. During the year 1921 surveys were completed in nine areas, including the Cloncurry-Hughenden, Longreach-Emerald, and Charleville-Dalby districts, which cover about 500,000 square miles and embrace most of the interior of Queensland.

Examination of 2,120 persons in the **Cloncurry-Hughenden** area showed only fourteen, or 0.66 per cent, infected, and all of these fourteen had received their infection in other regions. The conditions here with respect to rainfall are particularly unfavorable for the development and



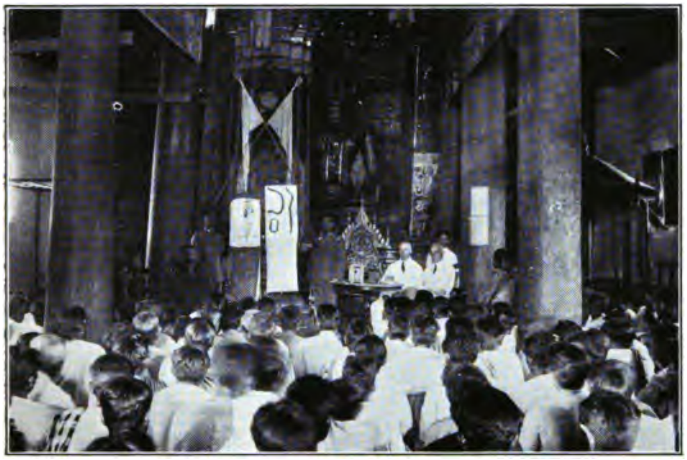
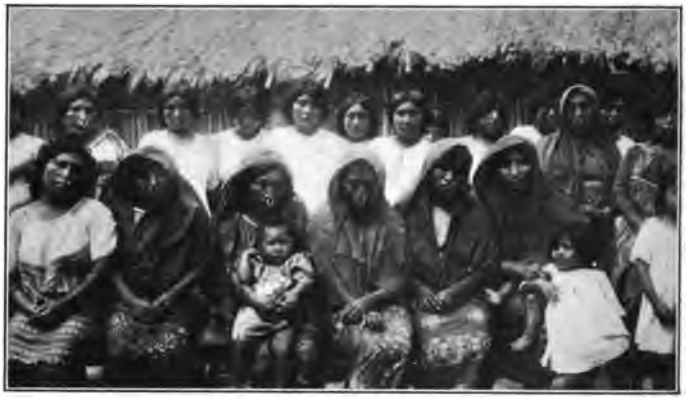


Fig. 33.—Ancient temples in Siam put at service of hookworm commission as headquarters for meetings and distribution of literature. Educational activities are an essential feature of the world-wide crusade against hookworm disease



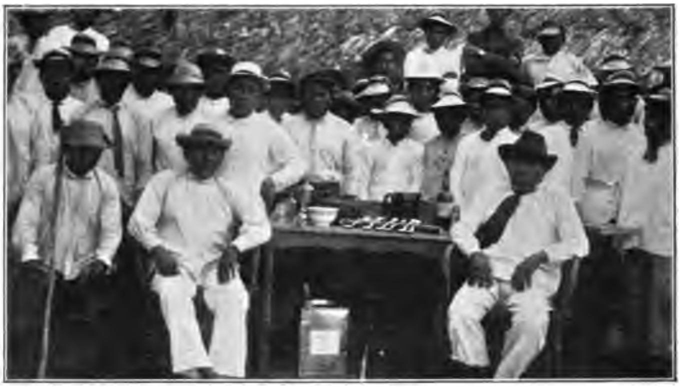


Fig. 34.—Groups of natives assembled for treatment, Tupile, Panama. Hookworm campaigns afford an excellent means of instructing primitive peoples in the rudiments of sanitation

spread of the disease. In fact, the whole area would seem to be definitely non-infectible.

In the **Longreach-Emerald** area examination of 759 children at selected state schools revealed nine cases of hookworm disease, or a percentage of 1.2. The low rainfall, producing dry soil conditions which interfere with the development of the larvae, and the large tracts of land held for pasture, with only an insignificant acreage under cultivation, are believed to be responsible for the low incidence. The survey demonstrated that the disease is almost certainly absent from the surface; the coal mines near Clermont, however, were not investigated.

In the **Charleville-Dalby** area 535 school children were examined and none were found infected. Here again low rainfall was chiefly responsible for the absence of indigenous hookworm disease.

Investigations were also carried out in a small area of fifty-nine square miles centering in the city of Rockhampton, Queensland. In this survey 4,931 persons were examined and only 1.03 per cent found to be infected—a rate too low to call for control operations. The low incidence in the Rockhampton district is explained by the fact that the city has an effective system of night soil disposal, while the district as a whole has little rainfall and but a small proportion of its total area under cultivation. The natives of Hammond Island, near Thursday Island, were examined and found, owing to their habit of living on the beach, to be entirely free of hookworm infection. In an area including Brisbane and vicinity the rate of infection recorded was only 1.4 per cent, and worm counts revealed the average severity also to be low. Only one small region in the state of Queensland remains to be visited by the survey staff—an area with a small population located at the southern end of the gulf of Carpentaria.

Papua. The territory of Papua, surveyed in 1917 by Dr. J. H. Waite, was again surveyed in 1920 by Dr. S. M. Lambert. The investigation, covering the seven months from May 14 to December 15, disclosed a high rate of hookworm infection as far as the survey staff was able to penetrate the country.

The total population of the 821 villages under government control is estimated at 50,000 and in addition there are 7,000 indentured laborers in the colony. The entire population, with the exception of a few whites, consists of native Papuans. The staff examined 6,141 indentured and 633 casual laborers on sixty plantations; 10,372 natives in 166 villages; and 759 natives in nine mission schools. On the plantations the rate of infection was 65.8; in the villages, 54.9; at the mission schools, 59.7. Among the ninety-two white residents examined, only 17 per cent infection was recorded.

There was little difference in the rate or the severity of infection between the villages and the plantations: the average village rate of infection was only 11 points lower than the average plantation rate. Grouped geographically the plantation rates ranged from 62.2 to 84.5 per cent, being highest in the Delta division, where rainfall and temperature are high and there is gross soil pollution. The village rates ranged from 33.5 to 79.7 per cent. Marked contrast existed between the infection rates of villages in the dry and wet regions, the average being 13.1 for the dry and 70.9 for the wet.

Hemoglobin estimates on 2,891 infected and 835 non-infected natives showed the average index of the infected group to be 55.7 as compared with 63.5 for the non-infected. The low hemoglobin index of the non-infected group is believed to be due in the main to malaria, a disease with which practically all Papuans are infected. Clinical hookworm disease existed in only 5 to 10 per cent of the natives examined. Estate managers report that marked benefits in health and strength have resulted from the course of treatment administered as a feature of the survey.

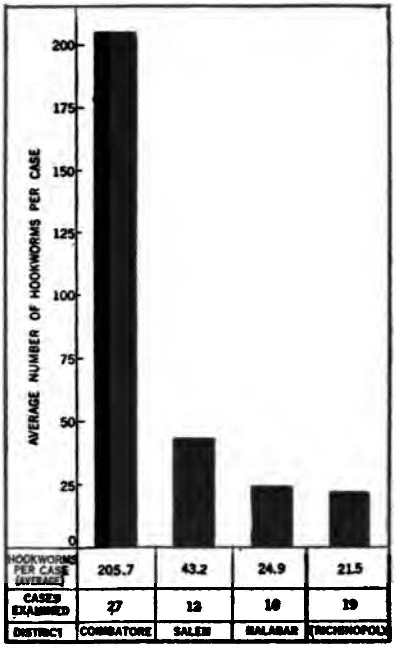


Fig. 35.—Average number of worms harbored by seventy-four coolies at work on the Mudis tea estates, Madras Presidency, India, grouped according to the coolies' districts of origin. Those from Coimbatore were almost entirely of the uncleanly Panchama class

INVESTIGATION IN CHANGWAT LAMPANG, SIAM

Under the new plan of organization adopted for Siam, survey units, operating from strategic centers, are starting out to cover the country in an effort to ascertain the prevalence and severity of hookworm infection and to assist the local authorities in developing among the people a sanitary sense. One such survey—that in the changwat Lampang, mondhol Maharat—was in progress from June 7 to September 9, 1921. Estimates based on the results of the survey indicate that approximately 200,000 of the 275,000 people living in the changwat harbor hookworms.

Examination of 4,038 persons revealed an infection rate of 75.0 per cent; in the four aumphurs in which examinations were made, the rates were 74, 71, 70, and 85 per cent. Among the general population the infection rate was 74.9; among school children 71.7; among prisoners 73.9; among gendarmes 78.3; and among soldiers 78.2 per cent.

The infection was of a moderate degree of severity. From 355 cases whose stools were saved for seven hours after treatment, a total of 8,181 hookworms were obtained, or an average of twenty-three worms per case. The largest number of worms expelled by any one person was 251. Hemoglobin determinations made on 503 school children gave, it is true, a low average index—74.5—but this was due to various contributing causes, including, in addition to hookworm, malaria and malnutrition.

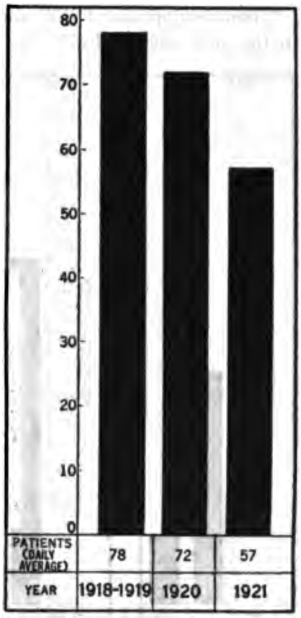


Fig. 36.—Average daily number of patients in Lionel Town hospital, Vere area, Jamaica, 1918-1921, inclusive. Following the anti-hookworm campaign in this area in 1920 there was a significant reduction in hospital cases

CONTROL EFFORT IN BRITISH HONDURAS

An infection survey carried out in British Honduras from February 7 to May 24, 1916, under the direction of Dr. L. W. Hackett, who was lent for the purpose by the Board, awakened considerable interest among the people, and on September 15, 1917, systematic examination and treatment were begun. Through courtesy of Government the Board has received a copy of the report of the campaign, prepared by Thomas Gann, the medical officer in charge, showing results accomplished up to May, 1921.

Approximately 15,000 of the colony's total population of 40,458 live in localities where the infection is so low as not to necessitate treatment. Of the remaining population, practically four-fifths have been reached by the treatment staff. Resurveys made during 1920 of districts whose inhabitants were treated two or more years previously, show substantial reduction in the incidence of infection.

The excellent results accomplished toward stamping out the disease are due in no small degree to the stress that has been laid on soil sanitation. From the beginning police and health authorities have insisted upon the provision of suitable latrine accommodation, until it may be said that at present nearly every place in the colony is provided with adequate sanitary latrines. The exceptions are certain remote

Carib and Indian villages, some small settlements of a few houses each, and lumber and other camps composed, usually, of only temporary habitations.

SURVEYS IN MISCELLANEOUS AREAS

Upon resumption of the campaign in **Dutch Guiana,** investigation in the area selected for initial control operations showed 92.2 per cent infection. A complement of from 300 to 400 worms was not unusual; two persons after a single treatment expelled more than 1,300 worms. From the republic of **Colombia** high rates of infection continue to be reported, the average for the areas embraced within the control program of the year being 92 per cent. In Quebradillas, the first area to be worked under the new plan of control approved for **Porto Rico,** an infection rate of 86.2 per cent was recorded among the 7,107 persons examined. Many severe cases were noted, though worm counts and hemoglobin estimations do not reveal a very severe general infection. In **Jamaica** an average infection rate of 39 per cent is reported for the districts worked during the years 1920 and 1921. In this colony a striking difference is reported in the infection rates for wet and dry districts, the average being 85 per cent for the former and only 10 per cent for the latter. The infection rate for the British Solomon Islands, just surveyed, is reported as 24.7.

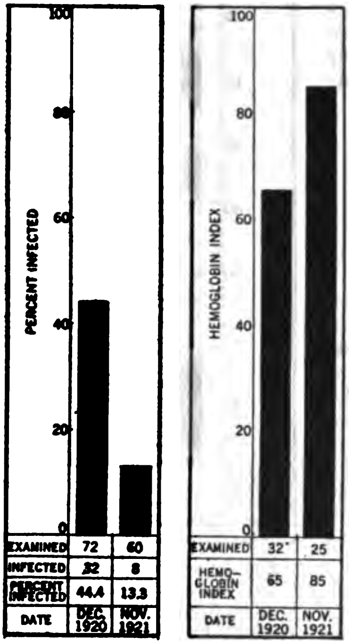


Fig. 37.—Effect of hookworm treatment administered in the Rio Cobre Home, Jamaica. The incidence of hookworm infection among the inmates was reduced and the hemoglobin index raised

BENEFITS OF HOOKWORM TREATMENT

Improvement in Health and Physical Condition, Jamaica

Statistics for the Lionel Town hospital in Jamaica, an institution which serves the estates and villages of the Vere area, where operations for the control of hookworm disease were carried out between November, 1919, and April, 1920, show that during 1918 and 1919 the average daily number of patients was seventy-eight, and during 1920, seventy-two. In 1921, following a campaign against hookworm disease in the area, it dropped to fifty-seven—a decrease in one year of 20.8 per cent (see Fig. 36, page 77). Before 1920 more than 80 per cent of the patients admitted to the hospital were infected with hookworm disease, as compared with not more than 5 per cent during 1921.

At another institution in Jamaica, the Rio Cobre Home, thirty-two children out of the seventy-two examined in December, 1920, had hookworm disease; in November, 1921, following a campaign against the disease in which all infected children received treatment, only eleven out of sixty examined were found to be infected. Meanwhile the average hemoglobin of all children in the institution had risen from 65 to 85, an increase of 30.8 per cent (see Fig. 37, page 78), and the average weight had increased from 46.5 to 51.6 pounds, or 11.0 per cent. Twenty-five of the children examined in 1921 were among the group of thirty-two who were cured of hookworm disease a year before, and eight of them were found to have been re-infected—a re-infection rate of 32 per cent.

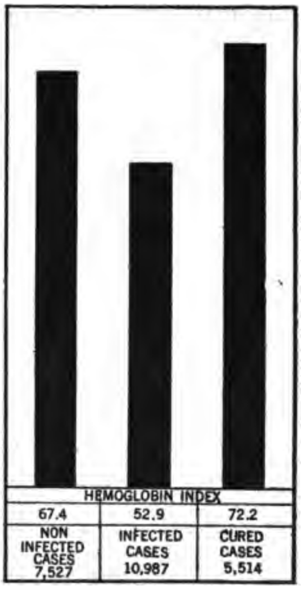


Fig. 38.—Hemoglobin indices of 18,514 persons in Costa Rica. Compare index of the group not infected with hookworm disease with that of the infected persons before treatment as well as after cure. In this country increased appetite, blood regeneration, and improved health promptly followed treatment for hookworm disease

Increased Efficiency of Sumatran Laborers

Recent official government correspondence from Mauritius calls attention to the fact that by means of control measures in Sumatra during the period from 1906 to 1918 the proportion of first-class coolies (those not infected, or only lightly infected, with hookworms) rose from 35 to 90 per cent, while that of moderately infected coolies fell from 50 to 10 and that of severely infected from 15 to 0.5 per cent. The number of badly infected coolies on insanitary estates in this colony averaged ten; on sanitary estates, three. The sanitary estates showed 1.8 per cent of coolies sick; the insanitary, 3 per cent.

Three estates in Sumatra which, in spite of all recommendations, refused to adopt hookworm control measures, had in the course of two and one half years 4,657 admissions to hospital. Three other estates with a laboring force of the same size which did adopt these measures had only 1,034 admissions—a difference of 78 per cent. One hospital admission represented on the average twenty-two days of treatment, which, reckoned at fifty cents a day, meant an aggregate loss of no less than 40,000 guilders during a period of only two and one half years.

II

LIFE OF HOOKWORM EGGS AND LARVAE IN THE SOIL

The department of medical zoology of the School of Hygiene and Public Health of the Johns Hopkins University dispatched to the island of Trinidad, British West Indies, during the summer of 1921, an expedition to study the life of hookworm eggs and larvae in the soil. The expedition was under the direction of Dr. William W. Cort of Johns Hopkins University and was aided by a subvention from the Board. Those who took part in the investigation included Dr. James E. Ackert of the Kansas State Agricultural College, Mr. Donald L. Augustine of Johns Hopkins University, Dr. George C. Payne, the Board's director in Trinidad, and his wife, Dr. Florence King Payne. The party from the United States sailed from New York May 5 and returned September 17. The work was conducted with the active co-operation of the Government ancylostomiasis commission and was carried out at Princes Town, in the south central part of the island in an area where sugar-cane cultivation predominates and over 70 per cent of the people are hookworm infected.

Finding of Unsheathed Hookworm Larvae in the Soil. Although various investigators have reported that under certain conditions mature hookworm larvae may lose their sheaths while still living in the soil, the general opinion has prevailed that they normally pass this period of their existence enclosed in sheaths and complete their second larval molt only when penetrating the human skin. Both field and laboratory studies in Trinidad showed, however, that it is a common occurrence for mature hookworm larvae to lose their sheaths while continuing to live in the soil. The loss of sheath, moreover, did not render the larvae non-infective.

Of a total of 4,265 mature larvae isolated from a series of 108 positive soil samples taken from an area of a sugar-cane field heavily polluted by individuals infected with hookworms, only 42 per cent were enclosed within the protective sheath. The finding was further supported by the studies of conditions under which hookworm eggs hatch and develop and of the migration of infective larvae, both of which showed that a proportion of the larvae became unsheathed while in the soil. The discovery will doubtless call for a revision of many former ideas that have resulted from a study of sheathed forms.

Length of Life of Larvae in the Soil. The discovery that so large a proportion of the larvae shed their skins while still living in the soil introduces a new factor for consideration in determining the length of larval life. Under favorable conditions this molting was not found to shorten the life of the larvae, although in unfavorable environments it did seem to decrease somewhat their chances of survival. Tropical temperature and other environmental conditions which tend to increase the activity of the mature hookworm larvae were found to shorten their lives through the more rapid using-up of the stored food material.

The Trinidad investigations showed that the life of larvae in the soil seldom exceeds six or seven weeks. Heretofore it had been believed that under favorable conditions of temperature and moisture they lived for months or even years. In the cane-field area, where there was intense soil infestation, the number of larvae was reduced more than 90 per cent within three weeks after soil pollution was stopped, only a very few larvae being left at the end of six weeks. Laboratory experiments with different soils under different conditions showed, too, a great reduction in the number of larvae in two or three weeks and an almost complete dying out in six weeks.

Relation of Chickens to Spread of Hookworm Disease. So far as Trinidad at least is concerned the expedition reported that chickens help to limit rather than to spread the disease. The great majority of hookworm eggs ingested by chickens failed to produce infective hookworm larvae after passing through the chickens' alimentary tracts, the failure being attributed in part to the breaking of eggs in the gizzards, to injury from urine in the chicken feces, and to malnutrition of the larvae. Although chickens that have swallowed hookworm eggs day after day may establish dangerous infective spots around drinking receptacles; although they may carry eggs and larvae from places unfavorable for their development and deposit them in favorable environments; and although they may transport to dooryards and other places traversed by barefooted persons human stools voided in out-of-the-way localities, the reduction of mature hookworm larvae brought about by the fowls was nevertheless found to be more than sufficient to offset the establishment of these additional infective spots.

Relation of Pigs to Spread of Hookworm Disease. The discovery of a new species of hookworm (*Necator suillus*) as being of common occurrence in the domestic pigs of Trinidad marked the study of the rôle played by pigs in disseminating the infection. The investigation showed, moreover, that the pig, ranging freely, is an important factor in the spread of hookworm infection. A high percentage of human hookworm eggs ingested by pigs were found to produce infective larvae, the hatching, during the rainy season in Trinidad, usually occurring within five days.

Effect of Hookworm Control Measures. To determine the sources of human infection and to learn the effect of a control campaign on soil pollution, on soil infestation, and on human infection, an intensive epidemiologic study was made of an area in a sugar estate. Of 146 East Indians and negroes living in the area chosen for study, 117, or 82.4 per cent, were found to be infected with hookworms. A series of three treatments greatly decreased the proportion of persons infected as well as the total number of worms harbored.

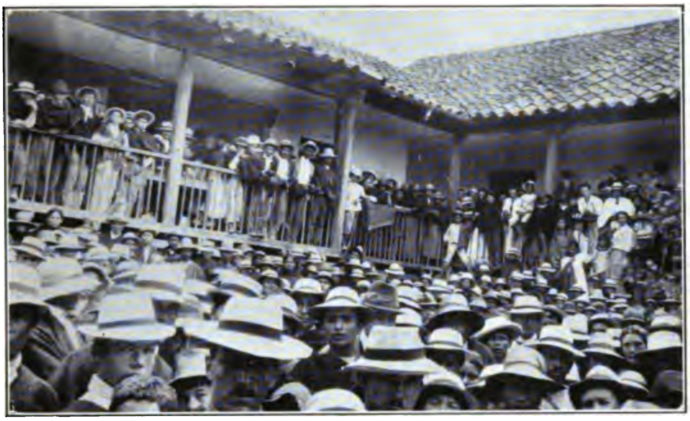


Fig. 39.—Group assembled to hear lecture and receive treatment for hookworm disease, Fusagasugá, Colombia

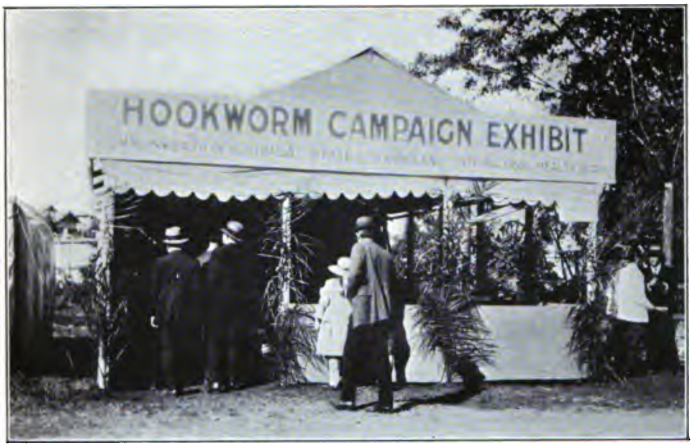


Fig. 40.—Exhibit on hookworm disease at the National Agricultural Exposition, Brisbane, Australia

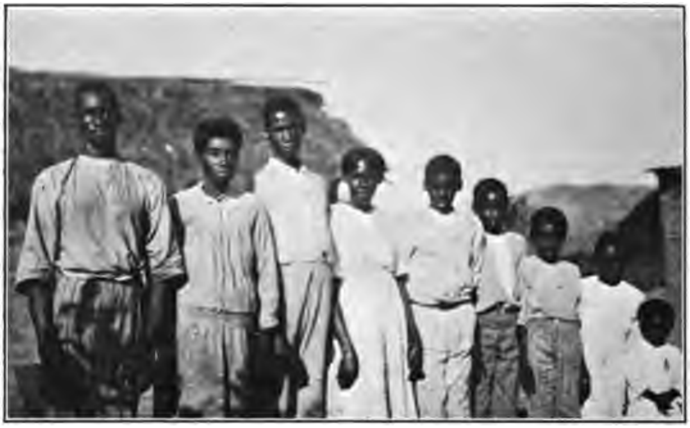


Fig. 41.—Negro family, residents of Federal District, Brazil. All except mother treated in 1919 for hookworm disease. Mother first treated in 1921, expelled 123 hookworms; other members of family, re-treated in 1921, expelled average of six worms

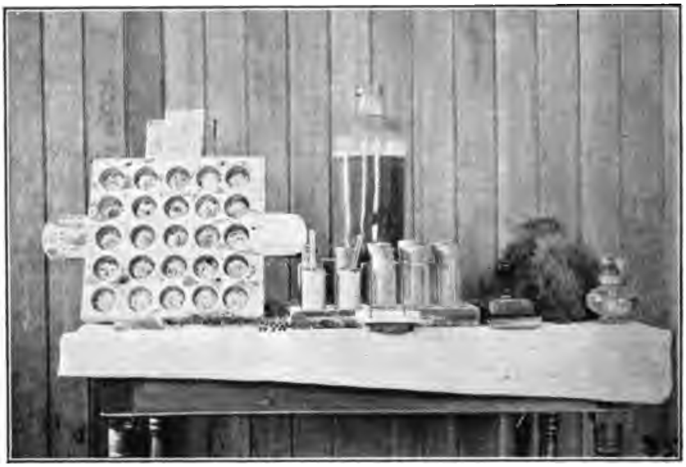


Fig. 42.—Examining board and other apparatus used in Jamaica in examining fecal specimens by the salt-flotation process. Great speed, accuracy, and economy are resulting from this and other improved methods of diagnosis

First inspection showed soil pollution in the area to be widespread and gross, though concentrated at certain easily accessible places in the cane fields near the barracks. Soil samples showed little soil infestation except along the heavily polluted strip of cane. The building of adequate latrines and the carrying on of an educational campaign effected great reduction in pollution in the cane field. A series of soil samples taken at intervals showed a rapid dying out of infective hookworm larvae, so that in about six weeks soil infestation was practically eliminated.

Examination of soil samples indicated that even if moisture was present, conditions on the clay loam soil were not favorable for the development of hookworm larvae unless there was considerable protection, especially by vegetation; and an analysis of the habits of the people in relation to the distribution of soil infestation suggested that most of the heavy infection was due to the practice of defecating at selected places in the cane field. The localized character of soil infestation, especially in the cane field, showed that there was little migration of infective larvae, although there was evidence that the larvae could be carried considerable distances by water.

Epidemiologic Study on Cacao Estate. Examination of the people living in three houses on a cacao estate showed a heavy infection with hookworms. As in the case of the sugar estate, pollution of the soil was confined almost entirely to definite spots, "natural latrines," in the cacao grove near the barracks. Here, again, examination of soil samples demonstrated that the larvae did not migrate and that almost all the human infection was derived from visits to the natural latrines. Even in this grossly polluted strip of soil, however, the findings were somewhat irregular, indicating that conditions were not always favorable for the larvae to develop. Six weeks after three routine treatments had been given, soil samples taken from the former heavily polluted spots showed marked reduction of soil infestation.

Migration of Larvae in Soil. Studies of migration showed definitely that hookworm larvae do not move from their original place of development unless carried away by the action of water or on the feet of man or one of the domestic fowls or animals. Larvae placed on moist soils did not migrate in periods of from fifteen hours to forty-two days. Not only did they not migrate even when their environment became unfavorable, but in the course of the experiment there was, through the dying out of the larvae, striking reduction in their numbers, the rate of reduction increasing with the passage of days.

Position of Larvae in the Soil. Infective hookworm larvae under the most favorable conditions of moisture and temperature were found to remain on or near the surface of the soil. They crept up pieces of wood, decaying vegetation, and other objects only as far as a film of moisture extended. They were not found within drops of water collected in the axils of leaves or green plants, nor upon the leaves themselves. At the centers of soil infestation they were found on the leaves or twigs when the latter were moist. When the leaves or twigs were dry, the larvae retreated to the underlying soil.

GREATER SPEED AND ECONOMY IN FIELD OPERATIONS

The demonstration by Cort and his associates that the life of hookworm larvae in the soil is much shorter than had been commonly supposed; that the larvae do not migrate; and the earlier demonstration by Smillie that hookworms are slowly acquired and slowly lost, find complete confirmation in the results of the 1921 resurveys of Governor's Island and Jacarepagua, Brazil (see pages 33 to 35). Not only do these findings abundantly confirm the fundamental soundness of the working methods that have been employed to effect the control of hookworm disease, but they indicate the lines to be pursued in future efforts to secure greater speed, economy, and efficiency in field operations. With the data now at hand it is possible to formulate a simplified plan of procedure based, not on removing the last hookworm from every infected individual, but on keeping reduced to a point at which they do no serious harm to the individual or to the community, the number of worms harbored. A paper recently published by Dr. Smillie gives the details of a method he has evolved to meet this end.[1]

Plan of Control for Heavily Infected Areas. In communities where almost all the people are soil workers—poor, ignorant, barefoot, spending ten or twelve hours daily in the fields, and subjected to all the factors that tend toward heavy infection—Dr. Smillie recommends a preliminary treatment campaign in which three treatments of a standard remedy would be given to all workers in the soil. Simultaneously the attempt would be made to secure the installation of latrines at not less than three fourths of the houses. After this proportion of the homes had sanitary latrines a second treatment campaign would follow. In the second campaign every positive case would receive only one treatment, and special effort would be made to treat all who work in the soil. Following this, a small staff would be stationed permanently in the community to secure the continued construction and maintenance of latrines, to treat newcomers, and to serve as the basis for a future rural health unit.

Plan for Lightly Infected Areas. In communities whose inhabitants generally are in better circumstances, accustomed to a better mode of living, and less severely infected, he recommends treating twice all positive cases except soil workers, whom he would treat three times, and at the same time inaugurating a campaign of latrine construction. Upon completion of treatment a small staff, who would remain to continue the work of latrine construction and to treat newcomers, would devote certain days of each week to general dispensary work, when they would treat any hookworm infected persons who came to the clinic. Here, again, the small unit would serve as the basis for extending permanent rural sanitary activities throughout the community. While hookworm infection would not be eradicated by either of these plans, hookworm disease would be adequately controlled if latrines were constructed and faithfully maintained and used.

---

[1] The Results of Hookworm Disease Prophylaxis in Brazil, by Wilson G. Smillie. *The American Journal of Hygiene*, January, 1922, v. 2, No. 1, pp. 91–94. Same reprinted.

Mass Treatment in Absence of Latrine Provision. In communities whose inhabitants suffer with severe hookworm disease and who either cannot or will not build and use latrines, treatment is the only method of attack that can be used. The Brazilian experience shows that an individual who receives two standard treatments and is thus freed of practically all his hookworms, but who reverts to the conditions of living which produced his first infection, does not usually regain a large complement of worms until at least three years have elapsed. Under such circumstances it is therefore safe to follow the plan of giving all individuals a standard treatment once a year.

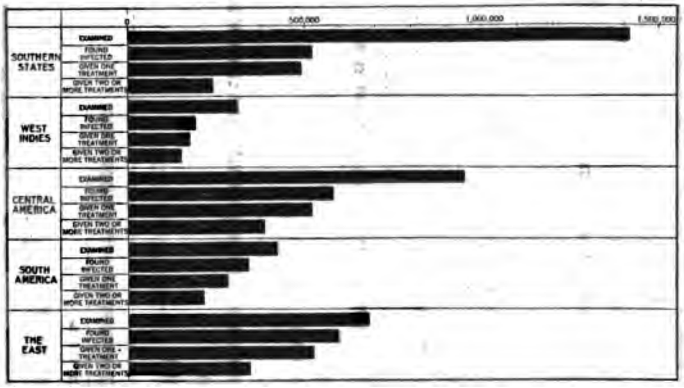


Fig. 43.—Number of persons examined and treated in world-wide campaign against hookworm disease, 1910–1921, inclusive, by main geographical divisions (for details, see Table 1, page 124.)

EFFECT OF SALT ON VIABILITY OF HOOKWORM EGGS AND LARVAE

A limited study of the effect of salt on the viability of hookworm eggs and larvae, carried out during 1921 by Dr. Fred C. Caldwell, director of hookworm control in Panama, showed that for all practical purposes sea water prevents the development of larvae. Particularly favorable conditions for the study were afforded by the habits of the San Blas Indians, who live on 227 islands stretched along 130 miles of coast and have the time-honored, inviolate custom of defecating in the sea. Non-Indian residents, however, frequently pollute the soil. In a number of localities on three islands having the same climatic conditions, the average rate of infection among 595 Indians examined was only 4.7 per cent, as compared with the rate of 62.9 per cent among thirty-five non-Indian residents.

In the Spanish village of Puerto Obaldia on the San Blas coast, where soil pollution was general, every person examined was found infected. A large proportion of the non-Indian population of all three of the islands had lived for considerable periods in the city of Panama, a fact that is doubtless responsible for the rate of infection being lower among them than it would have been if they had spent their whole lives on the islands. All the infected Indians had either spent extended periods on the mainland or had lived in close association with Jamaicans or Colombians while engaged in the gathering of rubber.

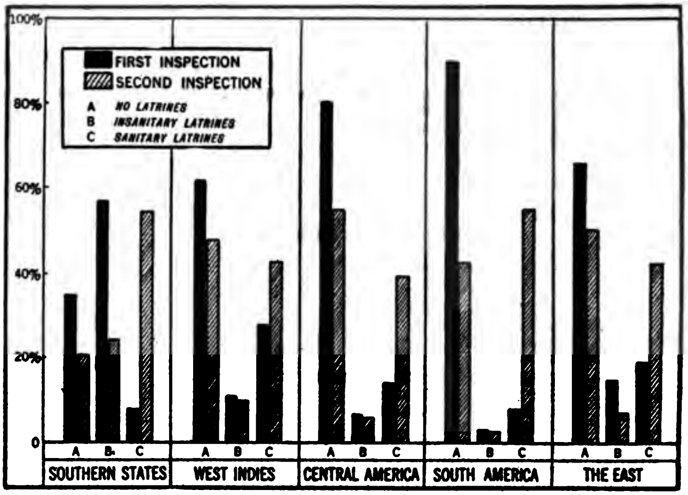


Fig. 44.—Sanitary conditions on first and last inspections compared for the five main geographical divisions of the world-wide campaign against hookworm disease, 1910–1921. In all regions extensive sanitary improvement has gone hand-in-hand with treatment

APPARATUS FOR RECOVERING HOOKWORM LARVAE FROM THE SOIL

The staff engaged in the investigations in Trinidad used with much success, in every phase of their work, a modification of the apparatus invented by Baermann for recovering larvae from the soil. It permitted determination to be made of the exact sources of infection through examination of large numbers of soil samples from various parts of areas in which hookworm disease was prevalent; it enabled the staff to follow closely the reduction of soil infectivity that resulted from the elimination of soil pollution; and it made possible not only a careful study of the conditions under which the eggs develop, but also of the extent of migration of the larvae, the rate of unsheathing, and the length of larval life in different kinds of soil.

The apparatus consists of a glass funnel almost filled with water and with the outlet closed by a clamped piece of rubber tubing. The soil sample is placed in a sieve so fitted into the funnel that the level of the water is above the lower surface of the soil, thus bringing the soil sample into contact with water of a considerably higher temperature than that of the soil. Under these conditions a large proportion of the nematodes pass from the sample into the water, where they can be collected and counted.

For examining soil samples of half a pint or more, large glass funnels eight inches in diameter, and specially prepared brass sieves seven inches in diameter, three inches deep, and with a one millimeter mesh, were used. To prevent small particles of soil sifting through into the funnels the sieves were lined with one or two thicknesses of cloth. It is possible to substitute for the sieve a piece of wire screen covered with cloth, of such a size that it can be fitted down into the funnel. The sieves have the advantage, however, of being more easily handled in changing samples of soil.

III

DIAGNOSIS OF HOOKWORM DISEASE

WILLIS SALT-FLOTATION TECHNIQUE

The Willis salt-flotation technique of stool examination found added favor in the work of the year. It is proving particularly valuable for detecting light infections usually missed by the less refined plain smear and centrifuge processes. In Salvador, for example, it increased by 10 to 15 per cent the number of specimens found positive with the aid of the centrifuge. In Ceylon 449 additional positives were found in a group of 1,569 specimens—an increase in efficiency of 28.6 per cent.

The process calls for adding to the feces a saturated solution of coarse table salt drop by drop until the container in which the specimen is received is filled to the brim. The mixture is thoroughly stirred and allowed to stand for a few minutes to permit the ova to rise. A clean polished slide is then placed on the container in contact with the surface of the fluid. In a short time the ova adhere to the slide, which is removed and examined with the microscope. The method is so simple, efficient, and economical that it is rapidly coming into use in all countries. Tests in Queensland showed that as compared with the brine flotation method the Willis technique had the advantage of being quicker; of requiring less apparatus, no steel wool and no wire loops being needed; of using less salt solution; and of permitting the discarding of the tins after use and so offering no possibility of ova being carried from one tin to another.

To facilitate examination by the Willis method Dr. Molloy, in Nicaragua, has improvised a special board which has proved effective in field work. The board—the end of a box in which gasoline is shipped—measures 13¾ by 9½ inches, and is covered on one side with a piece of tin to facilitate washing. To this board are nailed, in two rows, the tops of ten containers. The specimen containers are placed in these tops before the salt solution is added. The board is of a convenient size to handle and is easily cleaned.

LANE LEVITATION METHOD

Colonel Sir Clayton Lane, who has been at work for several years seeking to develop a technique of stool examination that will combine the utmost simplicity with the greatest refinement, recommends a levitation process and stresses the advisability of using chemicals to preserve the stools and so permit their examination under more favorable circumstances than are usually found in the field. The fact that levitation may be applied as successfully in preserved as in fresh stools, if certain disinfectants are used, offers the hope that it may prove practicable to effect further economy and efficiency by dissociating diagnosis, in time and place, from the other phases of hookworm work.

Dr. Lane finds that the process of levitation when properly carried out collects in a condition of full visibility an average of ten times as many eggs as can be secured by other methods of slide preparation. In Bengal, for instance, he added by levitation about 10 per cent to the infection figures obtained from strained and centrifuged films; and Dr. Mhaskar, testing the results of examination by searching the stools for hookworms after a vermifuge had been given, found that levitation had disclosed 7 per cent more positive cases than had been yielded by ordinary film examination. Dr. Lane is continuing his studies with the aid of a small subvention from the Board, and proposes to establish, by actual counts of eggs in fixed quantities of stool, what proportion of the eggs are lost and what proportion are collected in a condition of full, uncamouflaged visibility, in examinations by the plain smear, the centrifuge, the salt flotation, and the levitation techniques. In each case comparison will be made of the figures for stools treated and stools untreated by chemical preservatives.

ESTIMATING SEVERITY BY COUNTING EGGS IN FECES

Dr. W. G. Smillie conducted in Brazil during 1921 a test in which he sought to ascertain the possibility of estimating the severity of infection by counting the ova in the microscopic field. One hundred thirty-five cases harboring an average of thirty-two worms each, forty of which had been found negative with the microscope, were included in the test. The centrifuge method of examination was used, and the positive cases were classified into five groups in accordance with the number of ova found in the stools. The cases were later treated and all their worms expelled.

So far as general averages were concerned there was a definite relationship between the number of ova in the stools and the number of worms in the intestines, but in individual cases the clue afforded by a single examination of the stool was very unreliable. One individual having very abundant ova harbored only twenty-three hookworms; while others having so few ova that they were found only after long and careful search, harbored from 150 to 200 hookworms.

DIFFERENTIATION OF HOOKWORM AND STRONGYLOID LARVAE

In the routine examination of feces in field laboratories it is difficult to distinguish hookworm from Strongyloid larvae. Dr. Smillie has evolved a simple process for identifying the larvae, based on the marked differentiation that takes place as they mature. The technique results in many specimens being found to contain Strongyloides that are unrecognized by routine microscopic examination.

At the end of the day's work specimens containing the larvae to be identified are prepared in a Petri dish of standard size. In the center of the dish a circle from five to seven centimeters in diameter is drawn with a wax pencil or with cocoa butter. Within this circle are placed from one to two grams of feces and from one to two mils of water. The dishes are covered and allowed to stand at a temperature of from 75° to 90° Fahrenheit. The cultures may be observed on the following morning—fourteen hours after preparation,—and again on the second morning—forty hours after the culture was begun. The top is removed from the Petri dish and an ordinary hand lens is used in searching for larvae in the water surrounding the feces. During the interval of fourteen hours the larvae leave the feces for the surrounding water and swim freely about in large numbers.

The different habits and sizes of the two larvae render identification easy. The Strongyloides occur in two forms: the first as free living adult males and females, which usually appear near the margin of the feces and are of a size to be readily visible to the naked eye; and the second as filariform Strongyloid larvae found at the very periphery of the water, usually with their bodies at a right angle to the circle, and in active, even frantic, motion. Hookworm larvae differ from the free living Strongyloides in that they are many times smaller and are usually found at or near the fecal margins. They are sluggish in motion and thus offer a marked contrast to the active filariform Strongyloid larvae.

IV

MALARIA CONTROL

ANTI-MOSQUITO MEASURES: SOUTHERN STATES

Malaria control by anti-mosquito measures made marked progress in the Southern States during the year. Despite unfavorable financial and climatic conditions a total area of 225 square miles was controlled and a total population of 228,740 persons protected. Through joint co-operation between the town and county authorities, the state boards of health, the United States Public Health Service, and the International Health Board, new demonstrations were conducted in twenty-six towns in the states of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Texas; and in thirty-five other towns in these states and in Virginia supervision was given to the maintenance of control established in previous years. A considerable number of towns also conducted control measures on their own initiative and without outside assistance, a number of transportation and industrial corporations interested themselves in anti-mosquito activities, and from the towns the work began to spread to rural communities.

Measures Employed. In the work of control, effort centers on the elimination of the breeding places of malaria mosquitoes. The measures employed consist of simple drainage, filling borrow pits and shallow pools, channeling streams, clearing the margins of streams and ponds, removing obstructions, letting in the sunlight, oiling, and enlisting the services of the top minnow (*Gambusia affinis*) to keep down breeding. It is necessary also to protect unscreened or unsatisfactorily screened wells and cisterns and to remove or cover old tin cans and similar artificial containers.

In all towns in which work is conducted preliminary surveys are made to determine whether effective malaria control can be secured at reasonable cost. Whenever possible the surveys are made late in the summer or in the autumn of the year preceding the beginning of control effort. The drainage operations are usually so planned as to be practically completed before the mosquito season opens.

The measures employed, while practically eliminating the malaria mosquito, do not guarantee freedom from the mosquito as a pest. A significant decrease in the numbers of all mosquitoes—Culex as well as Anopheles—results, but it is much more difficult and expensive to obtain freedom from all mosquitoes than from Anopheles alone. To obtain complete mosquito control careful inspection of backyards and surrounding premises is required.

Results and Costs.[1] Figures 11 and 12 (pages 19 and 20) exhibit typical results accomplished. The reduction in malaria on the basis of physicians' calls is in the case of some towns as high as 90 per cent. Figures showing the reduction effected are not available for all towns, however, as information concerning malaria incidence is seldom recorded for the years that precede the control program.

---

[1] All cost figures given in this paragraph exclude the expense of general supervision.

Several towns reported that the control operations resulted in malaria being completely eliminated. Physicians were practically unanimous in reporting a marked reduction in the number of their visits for malaria, and pharmacists stated that there had been a noticeable diminution in the demand for chill tonics and similar proprietary "remedies" for malaria.

In the new towns the cost of original installation during 1921 ranged from $225 for the town with the lowest cost to $6,234 for that with the highest, the total for the twenty-six amounting to $67,411. Inasmuch as a total population of 67,063 was protected, distributed in towns varying in size from 268 to 13,088, the cost per capita was $1.01. In the other thirty-five towns the maintenance measures protected a total population of 161,677 at an average cost per capita of only twenty-five cents.

Data submitted by thirteen of the twenty-six installation towns indicate that the average first year's cost of each main feature of the work was as follows: ditching $345 per mile, clearing streams $95 per mile, and oiling $3 per mile. The average cost of maintenance was $16 per mile. Premises were inspected for mosquito breeding at an average cost of six cents. All of these costs, of course, are subject to wide variation depending upon conditions to be met. Nevertheless, it is felt that the averages are fairly representative. In some towns natural conditions made possible control at trifling cost. Thus, in Bullard, Texas, control was secured for only $66.83, of which $11.83 was spent for oil and $55 for the labor of applying it.

The effectiveness of the control program is well illustrated by statistics for the town of Lake Charles, Louisiana. This town, with its population of 13,088, was embraced within the extra-cantonment zone in which anti-mosquito measures were carried out by Government during 1917. For that year the estimated calls for malaria numbered 250. The next year, following the installation of control measures, the calls dropped to eight. Upon the close of the war control effort in the town and vicinity was permitted to lapse, with the result that the cases of malaria rose to 500 for the year 1920. In 1921, following the renewal of control effort in April of that year, the total number of cases was only fifty.

Economic Value of Work. Complete data are not available to show the economic loss that results from malaria, and estimates are in most cases difficult to make. Nevertheless, certain facts and figures collected during 1921 are at hand to indicate the saving in dollars and cents effected by the application of control measures.

Thus, the town of Lake Charles, Louisiana, sustained during the year 1920 losses from malaria estimated at $26,000. During 1921 control measures, which practically stamped out malaria and eliminated this loss, were applied at a cost of only $4,965, representing a saving to the town in its malaria bill of $21,035, or 81 per cent. Again, Mr. George L. Grogan,

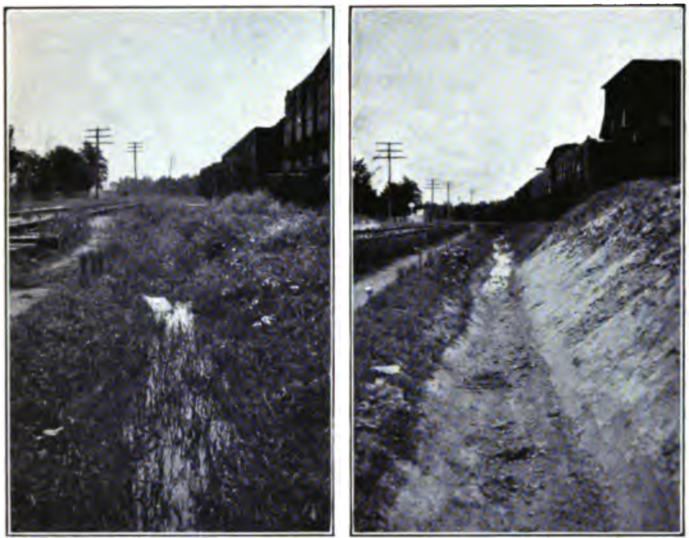


Fig. 45.—Ditch along railroad embankment, before and after draining, Demopolis, Alabama. Minor drainage operations constitute the chief feature of anti-mosquito measures as conducted in the Southern States

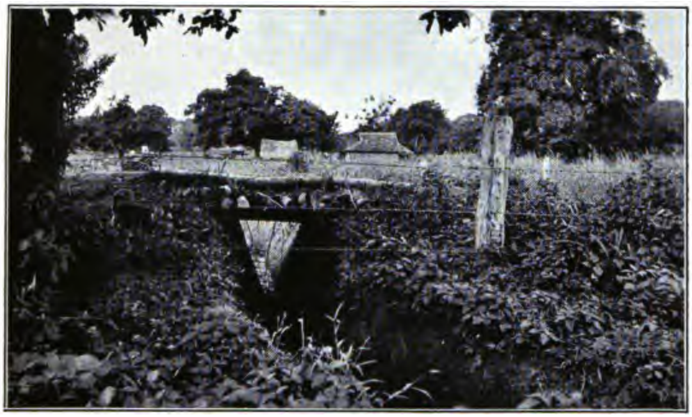


Fig. 46.—"V"-shaped ditch, a part of the drainage system installed to control malaria in and near La Puebla-Rivas, Nicaragua

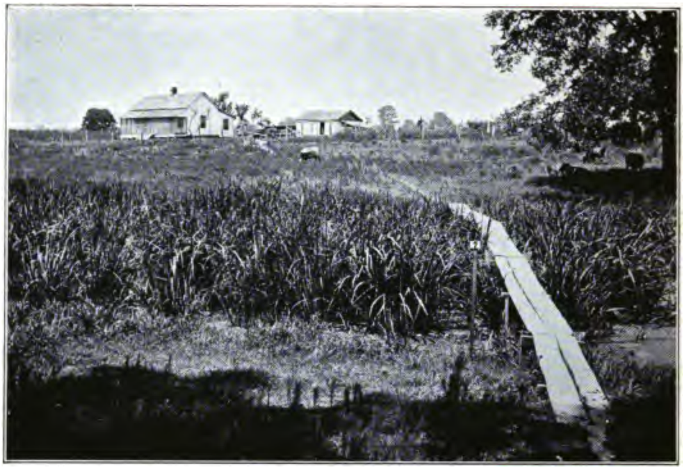


Fig. 47.—Anti-malaria, impounding water experiment at Mound, Louisiana. View across bayou, 700 yards above dam site, before clearing

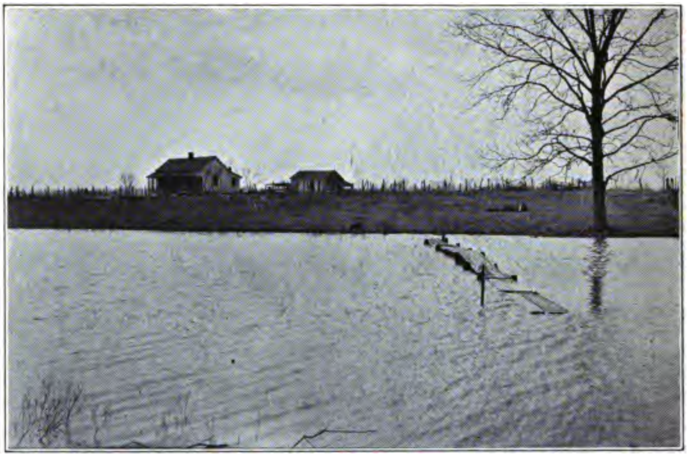


Fig. 48.—Same as Fig. 47, showing bayou filled with water

manager of the Grogan Lumber Company at Gladstell, Texas, states that the installation of control measures during 1921 cost the town a total of $5,036 and protected 500 people. In this instance the first year of control cut the company's malaria bill in half.

Public Appreciation. The work is meeting with high favor in all the states, as is evidenced by the fact that in practically all the towns where it has been begun there is almost no opposition to its continuation.[1] Many of the towns in which demonstrations are made continue the drainage work during the winter months and in the spring have the ditching in good order for early work to prevent mosquito breeding.

The town of Crossett, Arkansas, continued control measures during 1921 for the sixth consecutive year at a cost of $5,349 for the year; the town of Hamburg, Arkansas, completed its fifth, and the towns of Lake Village and Dermott, Arkansas, their fourth, successful year of malaria control (Figs. 11 and 12, pages 19 and 20, exhibit results accomplished). In all these towns the bulk of the citizens heartily endorse the work and there is every indication that it will henceforth be carried on as a regular municipal function.

Consolidation and Extension of Service. The work of the year has been characterized by a growing tendency to center control measures in the county health departments, and to arrange through them not only for the initial installation but for subsequent supervision and maintenance. The state boards of health are also taking active interest in the work, and many of them are securing their own malaria control personnel. During the year the Board assisted six of these states—Alabama, Arkansas, Mississippi, Missouri, South Carolina, and Virginia—in providing supervisors to assume direction of comprehensive plans for the control of malaria within their borders. The state boards of health have made creditable progress in securing legislative appropriations for developing and aiding in measures for the control of malaria. It is estimated that six states expended at least $50,000 in this way during 1921. Future plans contemplate the expenditure of much larger sums in this work.

COUNTY-WIDE ANTI-MOSQUITO MEASURES

The effectiveness of county-wide malaria control operations under the direction of a full-time county health officer was demonstrated during the past year in several Alabama counties. The effort grew out of the work conducted during 1920 in several towns of the state, which awakened interest in malaria control and suggested to the State Board the idea of attempting to carry out similar measures in both towns and rural districts through the county health departments. A malaria control engineer was added to the staff of the State Board, to co-operate with the county health officers, and Calhoun, Talladega, Sumter, Morgan, and Tuscaloosa counties were selected for the work. From the inception education and publicity were stressed.

---

[1] Following the original survey and before control effort is inaugurated the towns agree to defray certain items of expense associated with the work, as well as to set aside in future years the sums necessary for its maintenance. The agreement entered into with the towns contains careful estimates of original installation as well as maintenance costs. Persons who may be interested in the particulars of this phase of the work will be furnished a sample copy of the agreement upon application to the International Health Board, 61 Broadway, New York City.

Extent of Control Effort Undertaken. Active operations were begun April 1, 1921. By the end of April control effort was going forward in nineteen centers of population. Gradually other towns, and later the inhabitants of certain rural areas, took it up, until by the first of September it was under way in thirty-two towns and in fourteen rural districts. In some towns the regular city employes devoted to the work such time as was needed; in others the town marshal, assisted by prisoners, attended to it; in others still the towns paid nominal fees to some of their citizens. During the progress of operations in the five counties a total of 108 miles of ditches were dug, 1,298 miles of waters were oiled, and 86 miles of vegetation and other obstructions were cleared away from the banks of streams, ponds, and similar bodies of water. In addition 136 separate water deposits were stocked with the larvae-consuming top minnow, for the free distribution of which hatcheries were established at convenient locations in several of the counties.

Results and Cost. In the rural districts of all the counties many streams, lakes, and ponds were stocked with fish and many miles of ditches were dug. In one county in particular, where practically the sole source of Anopheles mosquitoes was stock ponds and small fish ponds, hundreds of these were stocked with Gambusia or were so cleaned by their owners that effective fish control was obtained. As a result a tremendous area was practically freed of Anopheles mosquitoes. The population protected in the several counties was 92,000, the total sum expended $3,108.11, and the cost per capita thirty-four cents.

ANTI-MOSQUITO MEASURES UNDER TROPICAL CONDITIONS

Efforts to adapt to tropical conditions the anti-mosquito measures whose value has been so convincingly demonstrated in the Southern States were continued in Porto Rico and Nicaragua during 1921. In both countries control is being sought by the use of top minnows, supplemented in Nicaragua by drainage and in Porto Rico by drainage and oiling. The complete results of the Porto Rican experiment are not yet known. The data at hand indicate that under tropical agricultural conditions in Porto Rico malaria cannot be controlled unless Anopheles breeding is prevented for a distance of at least 1¼ miles from the nearest house.

Demonstration in La Puebla-Rivas, Nicaragua. During March and April, 1921, surveys were made in two towns of Nicaragua—Buenos Aires and La Puebla-Rivas—to determine the feasibility of undertaking malaria control by anti-mosquito measures. The surveys resulted in the recommendation that experimental effort be undertaken in an area embracing approximately three square miles, forming part of the town of Rivas and the adjoining semi-rural district, really a part of the town, known as La Puebla. The work begun here in June has shown conclusively that anti-mosquito measures are applicable for the control of malaria in tropical towns, certainly under the conditions that exist in the towns of Nicaragua. The undertaking has awakened much interest in neighboring communities, a number of which are requesting assistance along similar lines.

Results and Costs in La Puebla-Rivas. No data are available for physicians' calls in earlier years. However, 43.6 per cent of the total population of 1,416 gave a history of attacks of malaria during the preceding twelve months. Examination of the blood of 200 persons, made for the purpose of checking the history index, yielded 139 positive results among 152 persons who gave positive histories, and indicated the histories to be approximately 90 per cent accurate.

During the period of control effort (June to December, 1921), which includes the period of highest malaria incidence (August to December), 27.7 per cent of the inhabitants had febrile attacks resembling malaria, indicating a diminution in the malaria rate of 36.5 per cent as compared with the incidence for the preceding year. A parasite index of 525 children, taken in August, 1921, and to be repeated in January and February and again in August of 1922, will give a truer estimate of results. There can be little doubt, however, that the degree of protection afforded was much higher than is suggested by the estimated reduction of 36.5 per cent, inasmuch as relapses unquestionably played an important part in raising the 1921 figures.

Excluding the expenditures for general supervision, the work was conducted at a per capita cost of seventy-four cents for the seven months it was in progress, or at an average rate of about one dollar for the year. This cost of original installation is slightly below the average cost of similar work in the Southern States. There is, moreover, every prospect that under Nicaraguan conditions the cost of maintenance will be considerably lower.

CONTROL BY STERILIZATION OF CARRIERS

The Mississippi delta is one of the regions in which the control of mosquito breeding is not economically feasible. In this region, therefore, experimental work in the control of malaria has been concerned with the sterilization of carriers. The work has been conducted under the general supervision of the Mississippi Department of Health and under the scientific direction of Dr. C. C. Bass, Professor of Experimental Medicine in Tulane University. It has been under way since 1916 and has dealt with many thousands of people. In the opinion of Dr. Bass its results indicate that with sufficient quinine available and the people sincerely desirous of being rid of the disease, *malaria may be controlled by quinine treatment alone* in any area of the world.

Extent of Experimental Effort. The study was conducted during 1916 and 1917 in an area of 328 square miles in Bolivar county, Mississippi. As a check on the results accomplished and while the figures for the Bolivar county work were being analyzed, work was also undertaken at the state prison farms in Sunflower and Quitman counties and at Parchman Penitentiary in Sunflower county.

The total population dealt with during the two years was about 35,000. During 1916 the work was conducted in an area of 225 square miles with a population of 20,040. A total of 37,841 blood specimens were examined during the year, and 13,403 quinine treatments were given. During 1917 an additional area of 103 square miles was covered and a large part of the 1916 area was investigated once or oftener to ascertain what effect the quinine treatment of the preceding year had had upon the incidence of malaria. A total of 45,889 blood specimens were examined during this year and 8,774 quinine treatments given.

Method of Treatment Experimentally Developed. The observations made during this two-year period shed considerable light upon many important questions involved in malaria control. Extensive tests of different salts and doses of quinine, carried on during 1917 at the prison farm in Sunflower county—because more dependable observations could be made on convicts than on free living people—together with experiments in methods of treatment followed by resurveys in various other communities during 1917 and 1918, made it possible to develop a standard treatment that gave promise of effectively immunizing the carriers.

Thorough investigations were undertaken to determine such questions as the total amount of quinine necessary to disinfect adults and children, the form in which the drug was most effective, the size of the daily dose, the manner in which the drug could be most conveniently and most effectively administered, the length of time over which treatment should be given, and the time or times of day at which it should be taken. Attention was also devoted to the question of whether or not there are persons to whom, because of a constitutional idiosyncrasy, the drug may not be administered.

Before adoption as part of the standard routine each particular phase of the treatment was experimentally tested and checked from carefully compiled records. The dosage finally decided upon was ten grains of quinine sulphate, with the following proportionate doses for children:

Age	*Proportion of Adult Dose*	*Dose for Children*
Under 1	0.05	½ grain
1 year	0.1	1 grain
2 years	0.2	2 grains
3–4 years	0.3	3 grains
5–7 years	0.4	4 grains
8–10 years	0.6	6 grains
11–14 years	0.8	8 grains
15 and over	1.0	10 grains

The medicine was to be taken at bedtime each night for a period of eight weeks. That the ten grains daily dose was about the smallest dose that could be depended upon to prevent multiplication of the parasites was shown by the fact that clinical symptoms developed in a few instances among the several thousand persons who were taking it. According to data collected the treatment disinfected more than 90 per cent of the carriers, relapses occurring in very rare instances. The studies indicated that there were few people to whom it was unsafe to administer quinine.

In two communities prophylactic treatment was used; that is, smaller quantities of quinine were administered over a longer period of time—not in an effort to cure or disinfect, but merely to guard against acute attacks. The results indicated that if such treatment were continued during the transmission season for several years, it would effect a great reduction in the incidence of malaria. However, thirty-two persons among the 1,657 who took prophylactic treatment suffered malaria attacks and had to be put upon curative treatment.

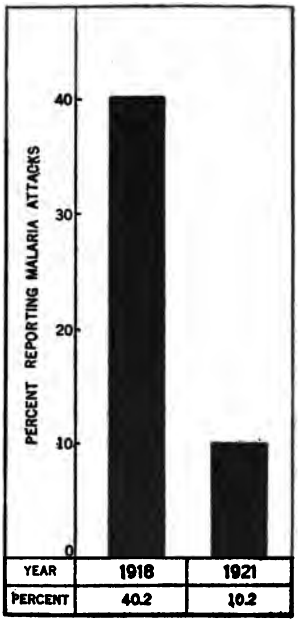


Fig. 49.—Quinine treatment controls malaria. In an area of 100 square miles in Sunflower county, Mississippi, only one third of the infected persons treated in 1918 suffered attacks the following year. Graph based on history index

Test of Treatment in Sunflower County, 1918. The next step was to test the efficacy of the immunizing treatment as a control measure in a typically malarious region. Accordingly, in 1918, a demonstration campaign was inaugurated in an area of 100 square miles located in Sunflower county, Mississippi. This area had a rural population of 8,052, with 1,000 additional persons residing in the town of Ruleville.

The proposed plan called for public meetings to advertise the scope and purpose of the work, for malaria surveys, for the furnishing of free quinine to all persons who gave positive histories or positive blood indices, and for following up the quinine treatment to see that it was taken on a regular weekly schedule. The work was to advance and to enter new communities as rapidly as conditions and facilities would permit.

Modification of Demonstration Effort, 1919–1921. This first demonstration achieved a considerable degree of malaria control. For the next year it was decided to discontinue *free* quinine treatment and to rely on county-wide publicity measures to stimulate the use of quinine in sufficient quantities for a cure. Practically nothing was done during 1919 in the 100 square mile area to hold what had been gained in the 1918 campaign, but the area was resurveyed in an effort to obtain further information about the results of the earlier work. During 1920 and 1921 there was a return to the 100 square mile area and an attempt to effect a further reduction in the incidence of malaria by persuading infected persons to buy the quinine and take the standard treatments. Intensive resurveys of the area were also carried on in both these years.

To summarize, the work of the four demonstration years was as follows:

1918—Intensive work in 100 square mile area.

1919—General publicity measures over entire county to induce infected persons to buy and take standard quinine treatment.
No special work in 100 square mile area except resurveys to determine results of 1918 effort.

1920—Return to 100 square mile area to check up results of 1918 work and to attempt further reduction in prevalence. As far as possible the various communities were taken up in the same order as in 1918. Intensive resurveys were made, complete records kept, and those who had malaria were advised to buy and take the standard quinine treatment.

1921—Same kind of resurvey and follow-up work as in 1920 conducted in 100 square mile area.

Result of Demonstration Effort. In spite of the fact that free distribution of quinine was discontinued at the close of 1918, that the majority of the people in the 100 square mile area were not again reached intensively until about two years later, and that quinine was not furnished them gratuitously even then, malaria was considerably less prevalent in the area at the close of 1920 than it was at the time of the first survey. Definite figures for the reduction accomplished to the end of 1920 cannot be announced until the returns for 1921 surveys have been completely studied. However, the number of cases of malaria per 100,000 residents during 1920 was 34.4 per cent lower in the 100 square mile area than in the whole county, and the death rate per 100,000 population was 65.9 per cent lower. Figures to the end of 1919 indicate, moreover, that the incidence of malaria was only 13.2 per cent among residents of the 100 square mile area who had been treated in 1918, as compared with the incidence of 40.2 per cent that obtained among these people at the time of their first quininization—a reduction of 67.2 per cent. In the intensive work in the 100 square mile area there was expended during 1918 the sum of $8,633.44, during 1920, $3,349.81, and during 1921, $3,454.72. For the respective years the per capita costs were $1.16, $.38, and $.38, or an average for the three years of $.70.[1]

Distribution and Sale of Standard Quinine Packets. The immunizing dose of quinine adopted after the experimental work in Bolivar and Sunflower counties was endorsed by the United States Public

---

[1] All cost figures exclude the expenditure for general supervision.

Health Service in 1918. In 1919 the National Malaria Committee adopted it and recommended it to practicing physicians and to the publishers of medical textbooks. State and county health departments in Mississippi and other states are now stimulating the distribution and sale of handy packets containing the standard treatment at all drug and crossroad stores. In the Southern States several million doses have been taken. Six hundred thousand were taken in one Georgia county alone during the year 1920. Among the 10,000 persons who took the medicine only twenty-seven developed chills and fever.

Determining the Malaria Carriers.[1] For estimating the prevalence of malaria in original surveys as well as resurveys, a combination of history and blood indices was used. In taking the histories only those persons were recorded as positive who had had attacks within twelve months. Persons who have not had attacks within this period are usually free of the parasites and are not malaria carriers. In no case was the blood of persons giving positive histories examined unless there was some special reason for so doing.

The blood of 31,459 persons was examined one or more times during 1916 and 1917, and malaria parasites were found in 21.2 per cent of the cases. More than half (55.1 per cent) of all the positive cases had stated, previous to blood examination, that they had had one or more attacks of malaria during the preceding twelve months; while 72.4 per cent of those who carried gametes had given a positive history. Thus, as is to be expected, the history index is shown to be more trustworthy when gametes are in the blood than when they are not.

EXPERIMENTS AT MOUND

At Mound, Louisiana, during the malaria seasons of the years 1920 and 1921, representatives of the United States Bureau of Entomology and of the International Health Board have conducted, along parallel lines, various field studies and experiments in malaria control in which the United States Bureau of Fisheries and the United States Bureau of Plant Industry have co-operated with the Bureau of Entomology. The investigations have dealt with control by screening, by the relocation of houses, by killing adult mosquitoes in the houses, by using mosquito netting over beds, and by impounding the water of bayous and depending upon top minnows and wave action to keep down breeding. As an incidental feature of the experiment in relocating houses, Dr. C. G. Bull of the Johns Hopkins School of Hygiene has co-operated in developing a technique for determining definitely the sources of blood meals of mosquitoes.

---

[1] Dr. Bass's final report will give full details as to the method followed in collecting and staining blood specimens and in microscopically examining specimens for the malaria parasite, as well as his observations on the relative accuracy of different persons who examine specimens in the laboratory and on various other technical subjects which were investigated in an effort to work out a thoroughly satisfactory method of diagnosis.

Impounding Water Experiment Highly Promising. Only one of the experiments—that of impounding water in bayous which cannot be drained—has proceeded sufficiently far for definite conclusions to be reached. This method, which was developed originally by the Bureau of Entomology and given further test through the co-operation of the International Health Board, has yielded results far beyond expectation.

The bayous of the Mississippi delta are streams flowing through channels cut by the river at flood. By means of damming, the bayous are converted into a series of lakes. The marginal zone is transformed into a pasture by removing tangled undergrowth along the edges, and domestic animals are introduced to crop close the vegetation along the water's edge and permit the waves and top minnows to act effectively. The maintenance of a water level sufficiently high to suppress the growth of aquatic and semi-aquatic vegetation, and a clear margin, are the essential conditions of success.

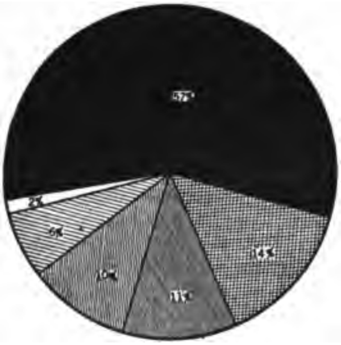


Fig. 50.—Proportionate rates of sickness from malaria and other diseases among rural population of seven counties in Southeast Missouri. Malaria caused 57 per cent of the total illness; digestive diseases, 14 per cent; respiratory diseases, 11 per cent; systemic infections (excluding malaria), 6 per cent; nervous diseases, 2 per cent. Ten per cent of the diseases could not be classified

Results of Impounding Experiment. A survey made more than a year after the completion of impounding gave only one collection of Anopheles larvae within the zone of control. Above and below it numerous specimens were obtained. The elimination of Anopheles breeding in the impounded section seemed to be the result of several factors, among which were: increased water depth, wave action, absence of vegetation near shores, absence of small organic and inorganic particles derived from submerged débris and vegetation, and finally larval reduction by fish.

Economic Return. Apart from the elimination of Anopheles breeding, several economic advantages resulted from the impounding experiment. Much additional pasturage was opened up; animals were provided with plenty of clean water throughout the dry season; and the supply of large edible fish became more abundant through the increased breeding produced under the more favorable conditions of the artificial lakes. The work of clearing the ground and constructing the dams cost only a little more than $600.

A MALARIA SURVEY IN SOUTHEASTERN MISSOURI

In counties or communities where the physicians and the people do not recognize malaria as an outstanding public health problem, surveys are necessary to determine the advisability of using public funds for its prevention. From August to December, 1921, Dr. Mark F. Boyd of the Board's field staff, in service with the Missouri State Board of Health, conducted such a survey in a group of seven counties containing a rural population of 147,845, constituting the southeastern corner of the state. He selected for intensive study a typical rural area of about 141 square miles, containing a population of 2,966. Some of his findings are interesting and significant.

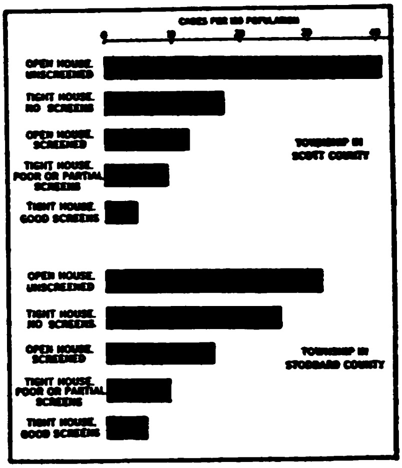


Fig. 51.—Effect of screening and construction of houses on incidence of malaria, two Southeast Missouri townships

These counties lie on the northern border of the recognized malaria zone for the United States, and yet Dr. Boyd finds malaria responsible for nearly 60 per cent of the illness. About 12 per cent of the entire rural population in the lowlands was found infected, with an estimated general malaria incidence of about 20 per cent. Of the people having attacks of malaria about 36 per cent consult a physician; about 16 per cent have no treatment; and the remainder dose themselves with chill tonics or quinine. None were found who had received what is regarded as the minimal dosage of quinine necessary to make a cure reasonably certain. The people living in open, unscreened houses have four times as much malaria as those living in well-built and well-screened dwellings. Difference in degree of protection against mosquitoes seems to be mainly responsible for the fact that the infection rate was found among farm-hands, 14.6 per cent; among tenants, 10.2 per cent; and among proprietors, 7.3 per cent.

The outstanding fact is that malaria in this region is on the decline; and that the principal cause of the decline is systematic agricultural drainage. Dr. Boyd's conclusion is that in this region anopheline control as a health measure is not economically feasible; and that the key to the control of the residual malaria lies in improving housing conditions to provide better protection against mosquitoes and educating the doctors and the people in proper standards of malaria treatment and the importance of effecting a cure (see Fig. 51).

V

FIGHTING MOSQUITOES WITH FISH

Fish played during 1921 a most important rôle in practically all the operations conducted against yellow fever and malaria. During the twenty years that have elapsed since 1900, when the United States Bureau of Fisheries began its investigations into the usefulness of the top minnow for destroying mosquito larvae, many experiments in the use of fish to keep down mosquito breeding had been made in various parts of the world, and some of them had yielded valuable and far-reaching results. Among them may be mentioned the work of the New Jersey Agricultural Experiment Station during the years 1902 to 1911; the observations of Geiger on the use of fish in rice fields near Lonoke, Arkansas; and the experimental work of Hildebrand, of the United States Bureau of Fisheries, near Augusta, Georgia, and elsewhere. Investigators in a number of other countries, particularly in India, have also made valuable contributions.

But the effectiveness of fish as a means of checking the breeding of malaria mosquitoes was first demonstrated under representative agricultural conditions in an experiment carried out by Dr. H. H. Howard in Hinds county, Mississippi, during the years 1918 and 1919. In a district thirty-six square miles in extent, with a population of 830 living in 172 homes, mosquito breeding was successfully controlled by the use of fish aided by only two inspectors. Fish were also used as an auxiliary but very effective measure of mosquito control in the campaign against yellow fever in Guayaquil in 1918 and 1919.

Elimination of Stegomyia Breeding Places in Guayaquil. In the city of Guayaquil, Ecuador, the main breeding places of the yellow fever mosquito—the large water-tanks—were covered and sealed, and fish were placed in the many smaller water containers that could not be so treated. The covering of the tanks greatly reduced the number of yellow fever cases; the use of fish in the smaller containers completed the eradication of the disease. Since then there has not been a single case of yellow fever in Guayaquil. During 1920, at a time when the supply of fish was temporarily exhausted, the percentage of containers other than tanks in which yellow fever mosquitoes were breeding rose rapidly from two to ten. The use of fish effected a notable economy in the cost of the campaign, making possible a reduction of the inspection personnel from 139 to 20.

Fish the Main Reliance in Peruvian Yellow Fever Epidemic, 1920–1921. For combating the severe yellow fever epidemic in Peru during 1920–1921, Dr. Hanson discontinued emptying and filtering and used fish in *all* classes of containers. The total of 750,000 fish that had been distributed by the end of 1921, brought down the mosquito

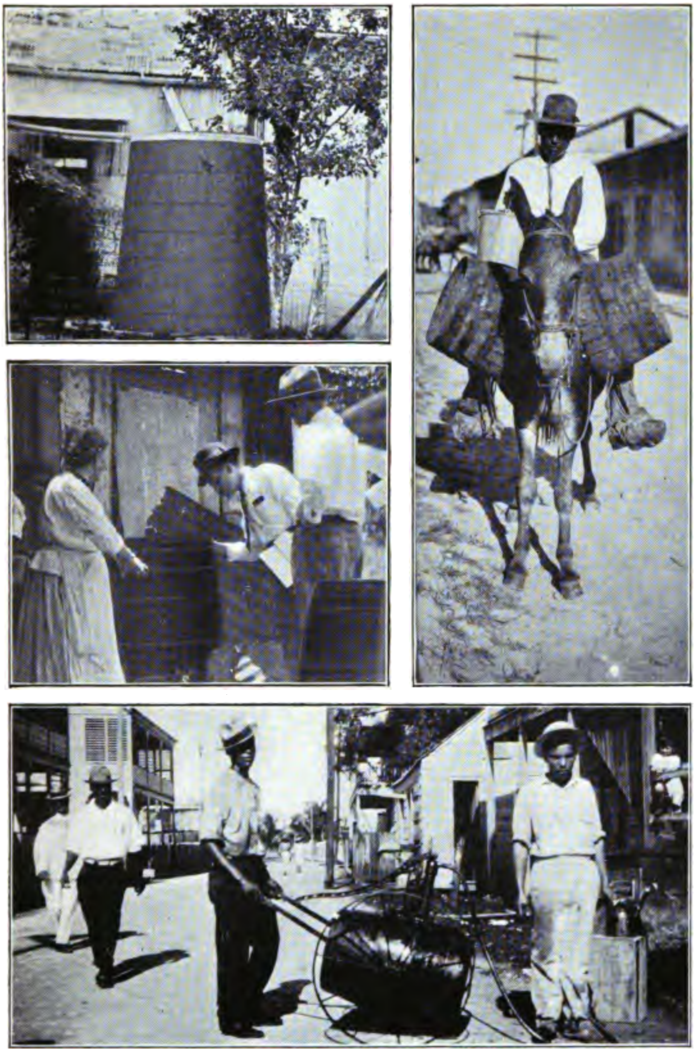


Fig. 52.—Several phases of yellow fever operations in Mexico and Central America. Home with water tank well screened; inspectors examining water barrels to detect possible Stegomyia breeding; fish distributor on way to landing place; oilers visiting homes to oil wells and small pools

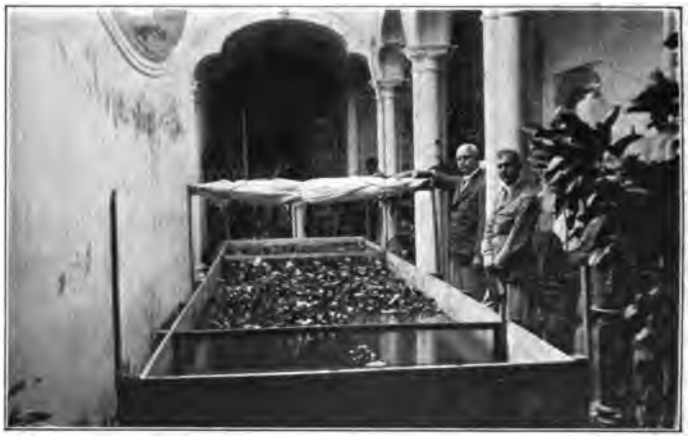


Fig. 53.—Tank at Colima, Mexico, from which are distributed the small fish placed in water containers at the homes. The fish devour the larvae of yellow fever mosquitoes in water containers

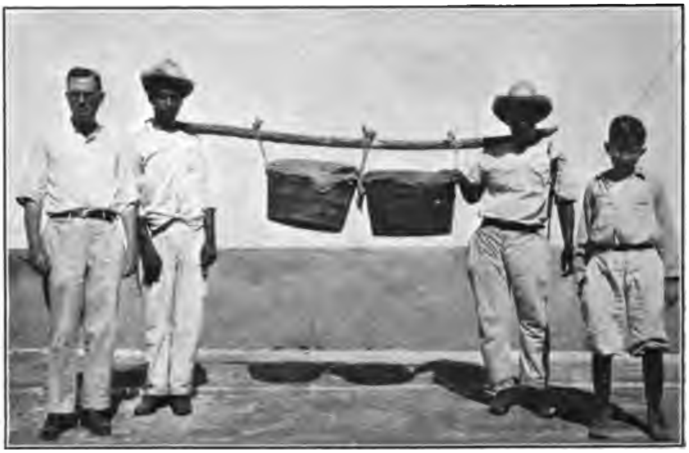


Fig. 54.—Transporting fish from landing place to headquarters. Operations against yellow fever in Túxpan, Mexico

index and held it to a safe limit over the territory lying between the sea and the mountains and extending from the borders of Ecuador to Lima, a region 500 miles long and from fifty to seventy-five miles wide. Dr. Hanson states that in his opinion the control of breeding over so vast an area would have been impossible but for the use of fish.

Fish the Chief Weapon in Mexican Yellow Fever Campaign, 1920–1921. The successful use of fish in other regions led to their being adopted by Le Prince in the summer of 1920 for the eradication of yellow fever in and around Tampico. The plan adopted for this city and the oil camps adjacent to it consisted of an intensive fish campaign in which every type of water container was stocked with suitable fish. As supplementary aids, and for securing control in bodies of water in which fish were not effective, oiling and other methods were resorted to. From a visit to about 500 homes in the city of Tampico in 1921, Dr. Connor estimated that the use of fish had yielded an 80 per cent degree of control.

a. Use of fish in Vera Cruz. Dr. Caldwell, director of the yellow fever control campaign in and around Vera Cruz in 1921, after visiting Tampico in 1920 to familiarize himself with Le Prince's methods, decided upon a campaign along similar lines for Vera Cruz. Fully one half of the containers in this city were of a type that held but little water and could be easily emptied. For these, frequent inspection with emptying and cleaning proved to be the most satisfactory method of control. Containers of the other large class, including barrels, *pozos*, and tanks, were covered where practicable. Where this could not be done, the introduction of fish gave highly satisfactory control. For the few containers and other breeding places that could not be covered and in which fish could not be used, it was necessary to resort to oiling.

b. Fish prove effective in Merida. In Merida, Yucatan, the *aljibe* (stone cistern constructed under the *patio*) was the preferred breeding place of the Stegomyia. Next, in the order named, came tanks, barrels, *lejia*, and smaller containers. To free the *aljibe* of breeding, fish were resorted to because covering was too expensive. Fish were also employed with excellent results in barrels, tanks, and other large containers. Small containers were emptied and their number reduced as much as possible. Dr. Connor, in his report for May, 1921, says that of 12,324 water containers in which fish were used, inspection revealed not a single one harboring larvae or pupae.

Use of Fish in Central America. In Nicaragua fish played a part in controlling the outbreak of yellow fever in Managua in August, 1919. They were not generally used in that country, however, until early in 1921. Dr. Molloy reports that they disappear from small *pilas* filled by taps, and from rain barrels, when the water runs over. In tanks, and in *pilas* filled from wells, however, they have given excellent results.

In the malaria control studies conducted in the department of Rivas, Nicaragua, during 1921, small fish of the Poeciliidae species were relied on exclusively to control breeding in streams and ponds. With proper clearing away of the underbrush and cleaning of the banks—a very inexpensive process—they yielded satisfactory control. To eliminate the principal breeding places of the region it was necessary merely to clean and straighten the banks of two rivers and give the top minnows a chance to perform their work. Fish were also used with excellent results to stop mosquito breeding in the artificial containers and wells found around houses.

In Salvador fish played an important rôle in maintaining, with a minimum inspection force, low mosquito indices in the principal cities. From hatcheries established in San Salvador and Sonsonate and in the Oriente, fish were widely distributed. In the opinion of Dr. Bailey fish alone would completely eliminate mosquito breeding if it were possible to secure proper care for all distributed and if the thousands of small containers in which they cannot be used could be emptied regularly or done away with.

A striking example of the part fish played in mosquito control is reported from the city of Sonsonate, Salvador. Even with persistent inspection of containers for many weeks it was practically impossible to reduce the house index below 4.2 per cent. Fish were then introduced, and in a very short time the index was reduced to 0.6 per cent. One year after the disappearance of yellow fever from Sonsonate, fish distribution was suspended, with the result that the percentage of houses in which Stegomyia were breeding rose rapidly from about 1 to 9 and the breeding in containers from 0.4 to 5.3 per cent.

In Guatemala fish have been effective in the classes of containers in which they can be used, but Dr. Vaughn reports that of the 30,000 containers in the yellow fever zone of that country only 2,900 are suitable for the use of fish. The larvae in those into which fish were introduced were greatly reduced in numbers despite the high mortality of the fish and the difficulty of keeping the containers adequately stocked.

Control of Malaria in the Southern States. In the Southern States fish are being extensively used to control the breeding of the malaria mosquito. In practically all the towns in which there have been demonstrations of malaria control by anti-mosquito measures during 1920 and 1921, they have been an important auxiliary to drainage and oiling and in many instances the chief or even sole reliance.

In a group of five counties in Alabama practically every farmer has convenient access to a minnow hatchery from which he is able to stock breeding places with fish as occasion arises. The city of Richmond, Virginia, has stocked all its fountains, reservoirs, and lakes with top minnows, and has established hatcheries to furnish the fish free of charge to any communities in the State that want them.

Kinds of Fish to be Used. In each locality a special study must be made of the kinds of fish available, of their habits, and of the conditions under which they are to be used. It is not safe to assume that because a certain species eats mosquito larvae in the laboratory, it will be useful in an anti-mosquito campaign. The larvae-eating habits of the species must be studied under conditions that closely approach those under which it is to be used. All authorities agree that an indigenous fish is preferable. If an indigenous variety is not used, the imported species must be thoroughly acclimatized and allowed to adjust itself gradually to its new habitat. Small fish of the family Poeciliidae, widely distributed throughout the tropical and temperate zones, are the ones most extensively employed.

VI

COUNTY HEALTH WORK

The county offers a most effective unit of organization for providing adequate health service to the smaller towns and rural communities. The need of such service was strikingly demonstrated by field investigations conducted in the Southern States between the years 1910 and 1915. Study of the sanitary conditions surrounding 274,420 homes in 747 counties in eleven states showed that only 12,145, or 4.4 per cent, had latrine accommodations that could be regarded as satisfactory for the prevention of soil-borne diseases. One hundred thirty-four thousand and eight, or 48.8 per cent of the homes, had no latrines; 128,267 others, or 46.7 per cent of the total, had the grossly insanitary open-seat surface latrines. Only here and there were county health departments maintained, but in such counties the sanitary conditions were better at the time of original inspection, it was easier to secure needed improvements, and the advantages, once gained, were seldom lost.

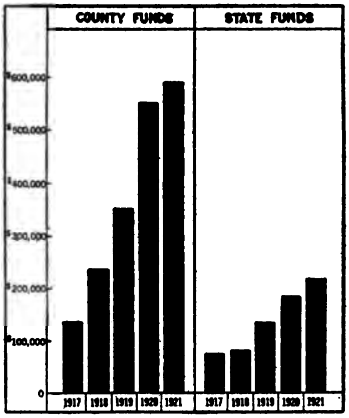


Fig. 55.—Growth in funds set aside for county health work, nine southern states, 1917–1921. Includes appropriations by states, counties, International Health Board, and other agencies

In the development of county health work the Board has been serviceable in providing funds for initial demonstrations. Its contributions have stimulated appropriations by counties and legislatures; and the demonstrations thus supported are creating a sustaining public sentiment. The state and county appropriations usually show wholesome growth from year to year, and are seldom reduced even in the face of the severe economic depression that has necessitated curtailment of many useful forms of service.

SCOPE AND EXTENT OF SERVICE

During the year 1921 co-operative projects in county health organization were carried out with the Board's participation in seventy-seven counties in sixteen states. The total sum appropriated by all the agencies which co-operated in these projects was $758,904, of which the counties themselves provided $344,081, the state boards of health $156,658, and the Board $177,777. The remaining $80,387 came from other sources, including the United States Public Health Service and the American Red Cross, or from municipalities and private corporations or individuals.

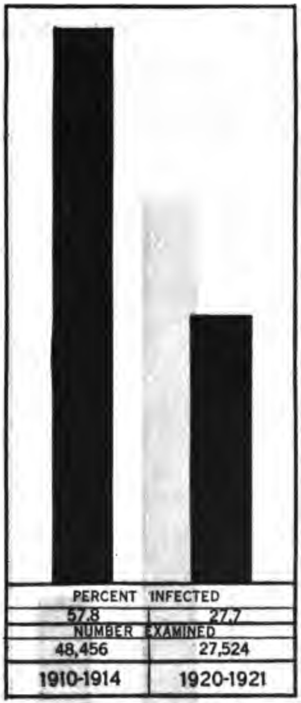


Fig. 56.—Reduction of hookworm infection rates, 1911 to 1921, in fifty-two counties in ten southern states. Based on the original infection surveys of 1911–1914, when 57.8 per cent of 48,456 school children examined were found infected, and the special re-infection surveys made during 1920–1921, when 27.7 per cent of 27,524 school children were found infected

During the year 1921 new work was begun or arrangements for beginning it were completed in five states in addition to the twelve[1] in which it was previously in progress. These five states were Florida, Indiana, Louisiana, Maryland, and Missouri. There was thus a total of seventeen states in which operations were under way or contemplated at the close of the year. The extension of the work has been most rapid in North Carolina, which now has twenty-seven full-time health departments, and in Alabama, which has eighteen.

The plan of work pursued by the county health departments has been evolved from experience, is applicable under a wide variety of conditions, and has stood the test of time. Though there are minor differences to meet local conditions, the most important activities, which are more or less common to all the units, group themselves under the following main heads: (1) public health education; (2) sanitation; (3) control of communicable diseases; (4) adult and child hygiene. The demonstrations are so planned as to enable any county to undertake at the start, in a small way and with the least expenditure of money, the line or lines of work which for that particular county give promise of yielding the greatest results in lives saved and sickness prevented. Other activities are added and the health department is expanded as the work proves effective and additional funds are provided.

---

[1] Alabama, Georgia, Kansas, Kentucky, Mississippi, New Mexico, North Carolina, South Carolina, Tennessee, Texas, Virginia, West Virginia.

PERSONNEL AND BUDGET

The personnel of the average county health department consists of a health officer, a sanitary inspector, an office assistant, and a public health nurse, though the staff is enlarged as occasion requires. The regular personnel serves on a full-time basis—a principle that is considered essential to the success of the work. The usual annual budget for a county of average size is $10,000, though the amount may be increased in the case of larger or more prosperous counties, or be reduced in counties whose population is small or resources limited. Sometimes two or more sparsely settled counties combine to operate a health department.

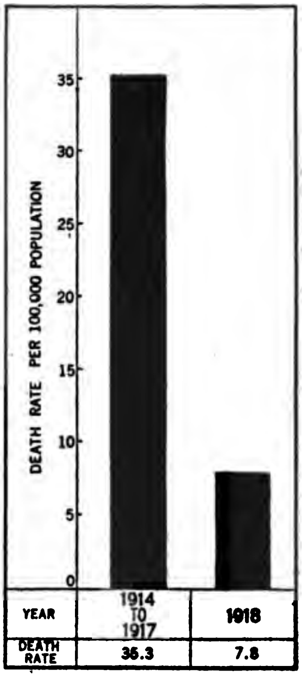


Fig. 57.—Average number of deaths from typhoid fever per hundred thousand population, nine North Carolina counties. Record for years 1914 to 1917, before inauguration of county health work, compared with that for 1918, the year succeeding its inauguration

In no case do the funds appropriated for the health department budget represent the total sum that the county residents devote to health protection. The work of the department invariably stimulates private expenditures for sanitary and other improvements that far exceed the amounts of the county budgets. To cite one of many instances, the citizens of Tazewell county, Virginia, contracted or paid out in four months during 1921 a total of $60,000 for sanitary improvements recommended by the health department, although the total budget for the department during this period amounted to only $3,000.

Public health nurses are being employed in increasing numbers. They furnish a close bond of contact between the health staff and the people. When a case of communicable disease is quarantined a nurse visits the home and gives advice as to the methods to be followed in caring for the patient and in preventing the spread of the disease to other members of the family or to the community; when children are found to be

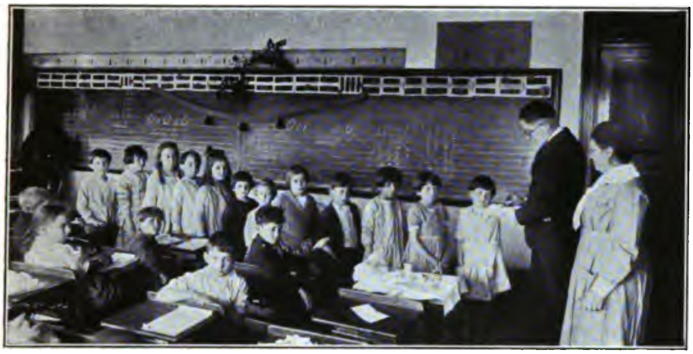


Fig. 58.—Health officer vaccinating children in rural school of Mason county, Kentucky. Small towns and rural communities, in increasing numbers, are providing themselves with health service of a type that has usually been found only in large cities

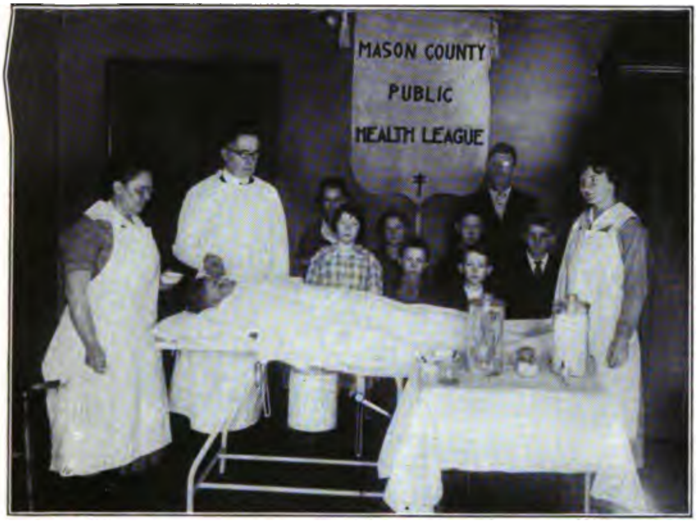


Fig. 59.—Trachoma clinic at Maysville, Kentucky, another feature of county health work as conducted in Mason county

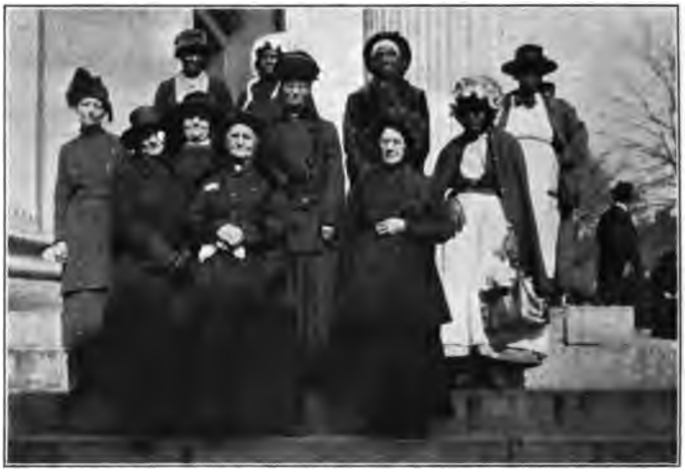


Fig. 60.—Class of midwives, with their instructor (second from left), Davidson county, North Carolina. Many of the county health departments are making the instruction of midwives an important feature of their service

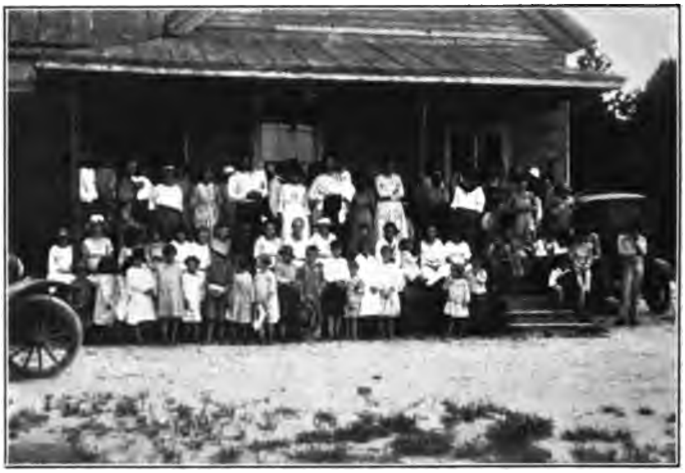


Fig. 61.—Children assembled to receive diphtheria immunization, Tyndale school, Lenoir county, North Carolina. The Schick test and toxin-antitoxin are proving effective weapons in the county health departments' fight against diphtheria

suffering from defects she consults with the parents and urges them to have the defects promptly corrected; and she renders valuable assistance to the health officer in the organization and conduct of clinics, in securing the co-operation of established welfare agencies, and in carrying out the general program of health education and community development.

ACTIVITIES UNDERTAKEN

The report for 1920 discussed somewhat in detail the activities usually embraced in the county health program. Of the newer activities undertaken by several of the departments during 1921, those concerned with county-wide effort for the control of malaria, with the use of the Schick test and toxin-antitoxin for the control of diphtheria, with measures against venereal diseases, and with the improvement of the physical condition of undernourished school children, may be worthy of separate discussion.

Anti-Malaria Work. The malaria operations conducted by the county health departments in Alabama have been fully discussed on pages 97 and 98. In other states also the departments undertook campaigns for mosquito control, advised suspected cases to have their blood microscopically examined and to consult a physician with regard to standard treatment if found positive, and in some instances they supplied free quinine in malarious districts. In the towns of Greenville and Farmville, North Carolina, it is reported that as a result of the anti-malaria work conducted during the past two years under the direction of the Pitt county health department, malaria was reduced at least 75 per cent.

Control of Diphtheria and Venereal Diseases. The health departments in many of the counties made extensive use of the Schick test and of toxin-antitoxin for controlling epidemics of diphtheria in the late summer and fall of 1921, when the disease became quite prevalent in many counties; and in other instances effort was devoted throughout the year to the control of venereal diseases. The measures against the latter disease consisted in the main of clinics, the closing of houses of prostitution, and caring for sufferers to insure their treatment until cured.

Nutritional Work in the Schools. The nutritional work undertaken in a number of counties effected much improvement not only in the weight of the children but also in their ability to keep up with their studies at school. In Montgomery county, Tennessee, 373 pupils from thirteen rural schools gained in weight within three to fifteen weeks an average of three pounds each as a result of such simple measures as serving them daily with milk and hot lunches and urging them to observe precautions in the care of the teeth, sleeping with windows open, and taking daily a sufficient amount of outdoor exercise. In one of the largest schools in this county, with 700 pupils, the percentage of underweight children was reduced during the school term of 1921 from 36 to 14. In

Blount county of the same state 883 children gained in the same period an average of 6.2 pounds.

Miscellaneous Newer Activities. In several South Carolina counties the local physicians organized and held during 1921 free clinics for the treatment of general diseases, with especially good results in Greenwood county; and in Kentucky and Tennessee, where trachoma is widely prevalent in certain sections, a large number of clinics were held for the relief of this disease. In all the counties the problem of insuring pure milk supplies is receiving early attention. For this purpose some of the units have added to their staffs a veterinarian who inspects the product of dairies and other milk-handling establishments and requires that it be brought up to standard.

RESULTS ACCOMPLISHED

The co-operative projects carried out during the year 1921 have yielded results whose value exceeds by many times the sums appropriated. During the year, in addition to the results accomplished in other lines of effort, new latrines were installed or old latrines improved and made sanitary at a total of 34,186 homes; 13,450 cases of communicable diseases were quarantined; 257,526 vaccinations were given for typhoid fever and 83,467 for smallpox; and 257,319 school children were examined for physical defects.

Reduction in Typhoid. Figures 16, 56, 57, and 62, pages 31, 113, 114, and 119, exhibit some of the instances of marked reduction in sickness and death that have been reported. In Alabama typhoid fever declined 60 per cent in the four-year period from 1917 to 1921—a period that exactly coincides with the bringing of the city water supplies throughout the state under the direction of the state health department and with the placing of more than 45 per cent of the state's inhabitants under the protection of county health departments. In a section of Smith county, Tennessee, where for many years there had been a high incidence of typhoid fever, a remarkable reduction resulted from an intensive vaccination campaign in 1919. During the four-year period from 1916 to 1919, inclusive, there were in this area twenty-one deaths from typhoid fever and more than 200 cases. During 1920 not a single case of the disease was reported. In Blount, Montgomery, Roane, and Smith counties the average number of deaths per year from typhoid fever during the period from 1915 to 1919 was 48.2. For the two-year period 1920–1921, following the organization of county health work, the number fell to 22.2, a reduction of 53.9 per cent. In Blount county the authorities estimate that a saving of $69,080 resulted from the service rendered by the county unit in reducing the incidence of typhoid fever.

Control of Smallpox, Diphtheria, and Other Epidemics. In Daviess, Harlan, and Scott counties, Kentucky, where in former years smallpox claimed a heavy toll, epidemics were averted in 1921 by the prompt action of the county health departments. In neighboring counties the disease was rife. In Harlan county the highest number of cases prevailing at any one time in 1921 was eighteen, as compared with more than 500 in the adjoining county of Bell, which had then no county health department. In Scott county only thirty-one cases of the disease occurred, which were limited to fifteen homes; and in Daviess county only twelve cases developed during the months of April, May, and June, 1921, as compared with 185 cases for the same period in 1920. In Geary county, Kansas, during 1921, the department more than paid for itself by preventing a threatened invasion of smallpox. In this county there were only fourteen cases of this disease, all of which were treated in their own homes. In an adjoining county the disease reached alarming proportions, necessitating the establishment of an emergency pest-house at an initial cost of $5,000, a sum greater than that provided by the residents of Geary county for maintaining their health department for one whole year.

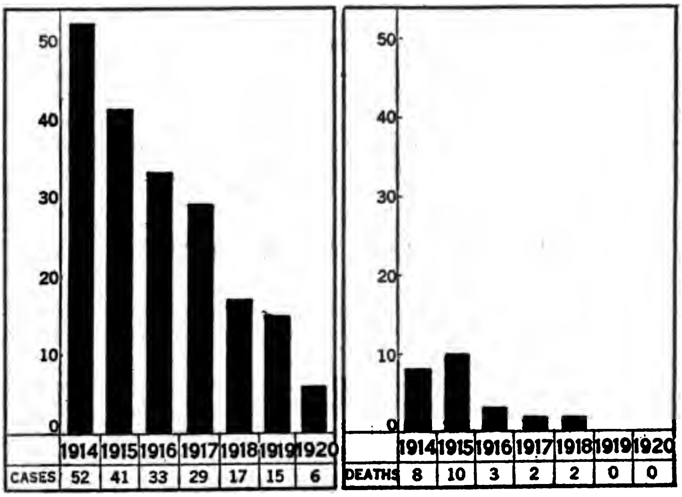


Fig. 62.—Control of typhoid fever in Pearl River county, Mississippi, incidental to the county-wide efforts to guard against pollution of the soil

In Williamson and Montgomery counties, Tennessee, what threatened to be serious diphtheria epidemics were checked by the prompt action of the county health departments in examining contacts and isolating carriers and positive cases. Scott county, Kentucky, has had in the past two years only one death from diphtheria, whereas several neighboring

Kentucky counties without full-time health departments have had as many as twenty or more. In the city of Santa Fé, New Mexico, a threatened outbreak of scarlet fever was completely checked by daily inspection of school children and exclusion of suspects. The people had become much alarmed when this infection appeared in 1921, as several years before there had been a persistent and widespread outbreak with the deaths running as high as fifteen a day.

Reduction of Hookworm Incidence. The hookworm resurveys carried out during 1920 and 1921 (see discussion, pages 30 to 32) showed that the reduction of hookworm disease has been greatest in the counties in which county health departments have been in operation. This result may be attributed not only to the treatment of infected persons but, and more particularly, to the improvement in sanitation that has been effected in recent years. The resurveys in their turn have proved effective in stimulating public interest in further hookworm control and in general health work. In Baldwin county, Alabama, the authorities estimate that hookworm disease is costing the county not less than $100,000 annually, and the systematic work of the county health department is gradually eliminating this loss.

CONTINUATION AND EXPANSION

The educational value of the work and the demonstration of the benefits to be derived from it find strongest expression in the action of the counties year by year in providing for its continuation and expansion. Coincident with the increase in funds there has been steady increase in the personnel engaged. The benefits of the work in one county, being seen and appreciated in adjoining counties, have led to demands for similar work. In Kentucky during 1921, for example, six additional counties—all of them adjoining counties in which work was already in progress—laid the foundation for whole-time health departments to be organized later.

The state of Ohio, which maintains its county health work independently of outside assistance, stands at the head of the list of states with respect to the number of counties having whole-time health departments. In Virginia, Alabama, Georgia, and North Carolina, however, the number of co-operative county projects has increased with great rapidity. The work has also spread from state to state until, at the close of 1921, it was no longer confined to the Southern States but was under way or contemplated in practically all sections of the country.

Not only are departments once established usually continued, but the appropriations for maintaining them are enlarged year by year, the range of activities undertaken is broadened, and in the end the departments, usually established at first on a trial basis for a period of one to three years, have been made permanent as the results they achieved have demonstrated to the people the wisdom of continuing them. As illustrating the manner in which the funds made available for the work are increased year by year, the record for the following five counties may be cited:

	1917	1918	1919	1920	1921
Mason county, Ky.	$4,400	$6,600	$6,400	$3,500	$10,000
Wilson county, N. C.	3,485	6,205	5,665	8,870	12,196
Davidson county, N. C.	3,485	6,205	5,665	8,741	9,000
Northampton county, N. C.	2,904	6,332	5,702	8,232	9,000
Lenoir county, N. C.	2,904	6,332	5,702	8,482	9,000

COUNTY HEALTH WORK IN OTHER COUNTRIES

As county health work in the United States has been developed and its various lines of procedure have become established on a fairly satisfactory basis, it has in turn served to stimulate more active interest in rural health work in other countries. As a result the Board has been asked to aid in conducting demonstrations in general rural health programs in a number of countries, including Brazil, France, and Czechoslovakia. During the year the first rural health unit in Brazil was established in the county of Sertãozinho, in the state of São Paulo; and the prospects are excellent that within the next two years similar work will be developed in the states of São Paulo, Minas, Rio, and Rio Grande do Sul. With variations in working procedure to meet special conditions, and with adequate local appropriations available, it would seem feasible, through the extension of this type of work to rural regions in many quarters of the globe, to effect the same reduction in sickness and death rates and the same promotion of human welfare that has attended similar effort in the United States.

STATISTICAL TABLES

NOTES ON TABLE I

1. Table 1 on the following pages presents a concise statistical summary —by the main geographical divisions of the work, by states and countries, and by years—of the persons examined and treated in the world-wide campaign for the relief and control of hookworm disease aided by the International Health Board. It shows that in the twelve years from 1910 to 1921, inclusive, a total of 3,770,624 persons have been examined in thirty-four[1] different states and countries, of whom 2,232,756, or 59.2 per cent, were found infected. Of those infected, 2,020,396, or 90.5 per cent, were given one treatment; while 1,352,550, or 60.6 per cent, received two or more treatments.

2. Two treatments of a standard remedy remove, on the average, from 88 to 95 per cent of the worms harbored, depending upon the drug used and the method of administration; and it is seldom that they leave more than ten worms in the intestine. Thus, though some persons may remain lightly infected after two treatments, this number is nevertheless adequate to establish what may be termed a "practical" cure. One treatment, similarly, removes from 75 to 90 per cent of the worms.

3. Though the figures have been itemized by states and countries and by years, this has not been done primarily to invite comparison of the results for one state with those for another, or of one year's work with that of another. Too many variable factors affect the results for such comparisons to be entirely valid. For instance, among other reasons, the variations or fluctuations may be due to the density of population or severity of infection in the areas of operation, to size of working staff, or to differences in the plan of work pursued. In other instances, as in British Guiana in 1919 and Dutch Guiana in 1921, the figures may represent results for only a few months instead of a complete year.

4. The table includes the results of the early dispensary effort aided by the Rockefeller Sanitary Commission in the Southern States. These figures are not itemized by years, but are reported, under the respective states, as the total for the years 1910 to 1914, inclusive. Some of the work for 1914, separately indicated, was aided by the International Health Board. Since 1915, when work by the dispensary plan ceased in these states, the chief effort against hookworm disease has been directed

---

[1] See footnote 4, page 134.

toward the building and use of latrines. Therefore the aggregate figures for examination and treatment are not so large as in previous years, nor do they represent in all cases such thoroughgoing effort in the curative phase of the work.

5. In a number of countries operations were suspended during the war and resumed after its close; in others there have been temporary periods of suspension due to industrial depression, lack of trained directors, or similar causes.

6. Only the results of campaigns aided directly by the International Health Board or Rockefeller Sanitary Commission are included. In a number of countries, as in Brazil, government or voluntary agencies are conducting extensive independent campaigns against the disease, the results of which, if they could be included, would substantially increase the aggregate examinations and treatments.

TABLE 1: *Persons Examined and Treated for Hookworm Disease, 1910 to 1921, inclusive, in World-Wide Campaign Aided by International Health Board. Figures by main geographical divisions of work, by states and countries, and by years*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
ALL COUNTRIES							
All Years	**3,770,624**	**2,232,756**	**2,020,396**	**1,352,550**	**59.2**	**90.5**	**60.6**
1910–1914	1,179,406	458,606	441,408	213,488	38.9	96.2	46.6
1914	35,397	17,791	16,106	11,925	50.3	90.5	67.0
1915	164,293	94,938	86,242	60,340	57.8	90.8	63.6
1916	223,976	133,744	126,834	93,302	59.7	94.8	69.8
1917	294,367	183,846	168,345	136,889	62.5	91.6	74.5
1918	374,330	249,103	215,394	164,577	66.5	86.5	66.1
1919	397,423	272,351	237,944	202,153	68.5	87.4	74.2
1920	479,916	340,456	297,322	240,983	70.9	87.3	70.8
1921	621,516	481,921	430,801	228,893	77.5	89.4	47.5
DIVISIONS							
SOUTHERN STATES							
All Years	**1,413,000**	**518,668**	**498,333**	**239,921**	**36.7**	**96.1**	**46.3**
1910–1914	1,179,406	458,606	441,408	213,488	38.9	96.2	46.6
1914	9,211	2,434	2,264	653	26.4	93.0	26.8
1915	18,145	3,961	3,779	931	21.8	95.4	23.5
1916	22,169	4,569	4,544	2,939	20.6	99.5	64.3
1917	37,299	7,834	7,596	6,293	21.0	97.0	80.3
1918	44,241	8,074	7,636	4,681	18.3	94.6	58.0
1919	26,282	10,266	9,391	6,689	39.1	91.5	65.2
1920	44,644	12,732	12,528	1,554	28.5	98.4	12.2
1921	31,603	10,192	9,187	2,693	32.3	90.1	26.4

WEST INDIES							
All Years	309,439	190,611	194,772	155,951	61.6	91.7	81.8
1915	63,062	38,026	33,648	24,559	60.3	88.5	64.6
1916	62,642	36,582	33,077	28,811	58.4	90.4	78.8
1917	75,779	46,051	42,739	40,738	60.8	92.8	88.5
1918	31,314	23,636	22,057	20,604	75.5	93.3	87.2
1919	20,350	14,537	13,534	12,962	71.4	93.1	89.2
1920	28,890	16,067	15,274	14,395	55.6	95.1	89.6
1921	27,402	15,712	14,443	13,882	63.6	91.9	88.4
CENTRAL AMERICA							
All Years	949,398	581,078	520,603	385,627	61.3	89.6	66.4
1914	5,321	2,907	2,562	578	54.6	88.1	19.9
1915	83,086	52,951	48,815	34,850	63.7	92.2	65.8
1916	131,520	85,235	82,461	57,534	64.8	96.7	67.5
1917	126,916	77,482	71,725	46,906	61.0	92.6	60.5
1918	169,531	107,449	94,176	71,078	63.5	87.6	66.2
1919	175,201	98,857	86,079	69,572	56.4	87.1	70.4
1920	134,439	77,537	67,160	50,427	57.7	86.6	65.0
1921	122,384	78,660	67,625	54,682	64.3	86.0	69.5
SOUTH AMERICA							
All Years	420,807	343,738	291,429	215,820	81.7	84.8	62.8
1918	10,490	6,922	5,894	4,208	66.0	85.1	60.8
1919	50,036	31,318	27,250	21,456	62.6	87.0	68.5
1920	109,337	83,475	73,901	61,276	76.4	88.5	73.4
1921	250,944	222,023	184,384	128,880	88.5	83.0	58.0
THE EAST							
All Years	678,980	598,661	535,259	355,231	88.2	89.4	59.3
1914	20,865	12,450	11,280	10,694	59.7	90.6	85.9
1916	7,645	7,358	6,752	4,018	96.2	91.8	54.6
1917	54,373	52,479	46,285	42,952	96.5	88.2	81.8
1918	118,754	103,022	85,631	64,006	86.8	83.1	62.1
1919	125,554	117,373	101,690	91,474	93.5	86.7	78.0
1920	162,606	150,645	128,459	113,331	92.6	85.3	75.2
1921	189,183	155,334	155,162	28,756	82.1	99.9	18.5

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
SOUTHERN STATES							
Alabama							
All Years	86,995	48,852	48,114	13,370	56.2	98.5	27.4
1910–1914	74,473	43,718	43,520	9,857	58.7	99.5	22.5
1917[3]	564	47	47	42	8.3	....	....
1918[3]	675	79	79	79	11.7	....	....
1919	102	17	17	15	16.7	....	....
1920	4,574	1,335	1,334	1,227	29.2	99.9	91.9
1921	6,607	3,656	3,117	2,150	55.3	85.3	58.8
Arkansas							
All Years	48,483	8,866	6,705	1,614	18.3	75.6	18.2
1910–1914	47,983	8,863	6,702	1,614	18.5	75.6	18.2
1918[3]	500	3	3	....	.6	....	....
Georgia							
All Years	75,341	46,058	45,552	14,251	61.1	98.9	30.9
1910–1914	73,518	45,564	45,095	14,023	62.0	99.0	30.8
1919	1,518	373	336	107	24.6	90.1	28.7
1920[3]	305	121	121	121	39.7	100.0	100.0
Kentucky							
All Years	134,855	44,404	38,611	872	32.9	87.0	2.0
1910–1914	128,991	43,635	37,916	475	34.6	86.9	1.1
1915[3]	1,833	460	460	316	25.1	100.0	68.7
1920	2,541	169	116	56	6.6	68.6	33.1
1921	1,490	140	119	25	9.4	85.0	17.9

Louisiana							
All Years	**74,368**	**39,342**	**38,556**	**14,858**	**52.9**	**98.0**	**37.8**
1910–1914	68,165	37,720	37,225	14,524	55.3	98.7	38.5
1914[3]	2,568	879	876	324	34.2	98.5	36.9
1918[3]	1,161	208	55	....	17.9	26.4	....
1921	2,474	535	400	10	21.6	74.8	1.9
Mississippi							
All Years	**280,707**	**109,809**	**108,323**	**74,496**	**39.1**	**98.6**	**67.8**
1910–1914	184,944	75,813	74,598	58,687	41.0	98.4	77.4
1915	4,414	1,422	1,410	53	32.2	99.2	3.7
1916	3,780	1,466	1,455	1,182	38.8	99.2	80.6
1917	14,874	4,348	4,228	4,223	29.2	97.1	97.1
1918[3]	8,468	4,084	4,069	3,541	48.2	99.6	86.7
1919	16,036	8,479	8,471	6,461	52.9	99.9	76.2
1920	31,198	9,730	9,720	42	31.3	99.9	.4
1921	17,043	4,467	4,377	307	26.2	98.0	6.9
North Carolina							
All Years	**337,179**	**112,639**	**106,828**	**60,264**	**33.4**	**94.8**	**53.5**
1910–1914	300,457	104,279	99,075	57,538	34.7	95.0	55.2
1914[3]	4,837	1,429	1,321	294	29.5	92.4	20.6
1915[3]	3,405	898	802	228	26.4	89.3	25.4
1917	9,048	2,057	1,984	1,149	22.7	96.5	55.9
1918	18,431	3,503	3,272	987	19.0	93.4	28.2
1920	728	238	142	....	32.7	59.7	....
1921	273	235	232	68	86.1	98.7	28.9
South Carolina							
All Years	**101,442**	**47,696**	**45,812**	**22,853**	**47.0**	**96.0**	**47.9**
1910–1914	81,311	42,677	41,751	21,413	52.5	97.8	50.2
1914[3]	840	90	31	4	10.7	....	....
1915[3]	3,581	721	648	230	20.1	89.9	31.9
1916	6,665	1,991	1,980	1,206	29.9	99.4	60.6

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
South Carolina—Cont'd.							
1918[3]	931	24	....	....	2.6	....	....
1919	4,966	1,057	327	....	21.3	30.9	....
1920	2,268	989	965	....	43.6	97.6	....
1921	880	147	110	....	16.7	74.8	....
Tennessee							
All Years	81,582	22,310	21,680	16,087	27.3	97.2	72.1
1910–1914	74,997	21,410	20,979	15,828	28.5	98.0	73.9
1915[3]	1,172	116	116	20	9.9	100.0	17.2
1916	1,217	49	48	23	4.0	....	....
1917	856	129	126	71	15.1	97.7	55.0
1918	127	3	3	2	2.4	....	....
1919	878	17	9	3	4.5	....	....
1920	608	26	17	7	4.3	....	....
1921	2,227	560	382	133	25.1	68.2	23.8
Texas							
All Years	89,482	19,947	19,492	4,861	22.3	97.7	24.4
1910–1914	63,376	17,790	17,490	3,588	28.1	98.3	20.2
1916[3]	2,801	570	568	357	20.3	99.6	62.6
1917	7,084	1,058	1,021	662	14.9	96.5	62.6
1918	11,025	81	70	51	.7	....	....
1919	3,044	322	230	103	10.6	71.4	32.0
1920	2,115	123	112	100	5.8	91.1	81.3
1921	37	3	1	....	....	....	....

Virginia							
All Years	**102,516**	**18,745**	**18,660**	**16,395**	**18.3**	**99.5**	**87.5**
1910–1914	81,191	17,137	17,057	15,941	21.1	99.5	93.0
1914[3]	966	36	36	31	3.7	....	....
1915[3]	3,740	344	343	84	9.2	99.7	24.4
1916	7,706	493	493	171	6.4	100.0	34.7
1917	4,873	195	195	146	4.0	100.0	74.9
1918	2,923	89	85	21	3.0	....	....
1919	238	1	1	....	.4	....	....
1920[3]	307	1	1	1	.3	....	....
1921	572	449	449	....	78.5	100.0	....
WEST INDIES							
Antigua							
All Years	**18,599**	**2,919**	**2,634**	**2,566**	**15.7**	**90.2**	**87.9**
1916[3]	7,477	2,229	2,054	2,031	29.8	92.1	91.1
1917[3]	11,122	690	580	535	6.2	84.1	77.5
British Guiana							
All Years	**71,322**	**44,073**	**39,906**	**35,394**	**61.8**	**90.5**	**80.3**
1915	21,070	13,135	11,903	10,039	62.3	90.6	76.4
1916	18,498	9,808	8,263	6,225	53.0	84.2	63.5
1917	16,044	9,508	8,906	8,722	59.3	93.7	91.7
1918	11,719	8,727	8,175	7,900	74.5	93.7	90.5
1919[3]	3,991	2,895	2,659	2,508	72.5	91.8	86.6
Dutch Guiana							
All Years	**18,494**	**16,762**	**15,544**	**14,792**	**90.6**	**92.7**	**88.2**
1916	4,411	3,900	3,667	3,414	88.4	94.0	87.5
1917	13,159	12,045	11,133	10,664	91.5	92.4	88.5
1921[3]	924	817	744	714	88.4	91.1	87.4
Grenada							
All Years	**33,164**	**22,120**	**20,571**	**15,650**	**65.2**	**99.6**	**70.8**
1915	20,042	12,652	11,522	8,064	63.1	91.1	63.7
1916	5,312	4,226	4,147	2,950	79.6	98.1	69.8
1917	7,810	5,242	4,902	4,636	67.1	93.5	88.4

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
Jamaica							
All Years	**26,397**	**8,552**	**7,705**	**7,129**	**32.4**	**90.1**	**83.4**
1919[3]	2,842	1,552	1,346	1,291	54.6	86.7	83.2
1920[3]	13,748	3,915	3,605	3,203	28.5	92.1	81.8
1921	9,807	3,085	2,754	2,635	31.5	89.3	85.4
St. Lucia							
All Years	**37,436**	**22,572**	**21,589**	**17,661**	**60.3**	**95.6**	**78.2**
1915	7,924	4,436	4,106	2,177	56.0	92.6	49.1
1916	6,003	2,336	2,201	1,904	38.9	94.2	81.5
1917	4,601	3,060	2,962	2,653	66.5	96.8	86.7
1918	5,004	3,126	2,892	2,068	62.5	92.5	66.2
1919	4,350	2,597	2,547	2,364	59.7	98.1	91.0
1920	6,373	4,743	4,656	4,331	74.4	98.2	91.3
1921	3,181	2,274	2,225	2,164	71.5	97.8	95.2
St. Vincent							
All Years	**21,915**	**12,758**	**11,905**	**11,383**	**58.2**	**93.3**	**89.2**
1915[3]	3,822	1,676	1,590	1,562	43.9	94.9	93.2
1916	7,494	4,062	3,748	3,653	54.2	92.3	89.9
1917	9,482	6,065	5,683	5,303	64.0	93.7	87.4
1918[3]	1,117	955	884	865	85.5	92.6	90.6

Trinidad							
All Years	**82,112**	**60,855**	**54,918**	**51,376**	**74.1**	**90.2**	**84.4**
1915[4]	10,204	6,127	4,527	2,717	60.0	73.9	44.3
1916	13,447	10,021	8,997	8,634	74.5	89.8	86.2
1917	13,561	9,441	8,573	8,225	69.6	90.8	87.1
1918	13,474	10,828	10,106	9,771	80.4	93.3	90.2
1919[3]	9,167	7,493	6,982	6,799	81.7	93.2	90.7
1920	8,769	7,409	7,013	6,861	84.5	94.7	92.6
1921	13,490	9,536	8,720	8,369	70.7	91.4	87.8
CENTRAL AMERICA							
Costa Rica							
All Years	**303,106**	**158,358**	**146,622**	**101,802**	**52.3**	**2.6**	**64.3**
1915	30,297	19,401	18,816	12,152	64.0	97.0	62.6
1916	40,579	22,608	22,037	9,899	55.7	97.5	43.8
1917	48,488	29,940	28,909	19,180	61.7	96.6	64.1
1918	56,371	29,898	27,487	19,154	53.0	91.9	64.1
1919	64,371	29,872	26,551	22,798	46.4	88.9	76.3
1920[3]	30,575	9,700	8,163	6,368	31.7	84.2	65.6
1921	32,425	16,939	14,659	12,251	52.2	86.5	72.3
Guatemala							
All Years	**201,250**	**131,558**	**117,380**	**106,283**	**65.4**	**89.2**	**80.8**
1915[3]	25,587	15,001	13,783	11,851	58.6	91.9	79.0
1916	39,596	26,665	25,961	23,618	67.3	97.4	88.6
1917[3]	12,934	7,095	6,693	6,518	54.9	94.3	91.9
1918[3]	32,861	22,299	19,950	19,057	67.9	89.5	85.5
1919	44,495	28,752	25,283	23,639	64.6	87.9	82.2
1920	21,460	12,805	11,429	10,402	59.7	89.3	81.2
1921	24,317	18,941	14,281	11,198	77.9	75.4	59.1

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
Nicaragua							
All Years	**129,780**	**88,036**	**78,869**	**45,010**	**67.8**	**89.6**	**51.1**
1915[3]	2,192	1,659	1,298	18	75.7	78.2	1.1
1916[3]	12,829	9,073	8,362	1,166	70.7	92.2	12.9
1917	33,781	18,422	16,950	5,388	54.5	92.0	29.2
1918	19,786	15,016	13,679	9,286	75.9	91.1	61.8
1919	12,246	5,820	4,829	1,657	47.5	83.0	28.5
1920	33,128	25,272	22,035	16,615	76.3	87.2	65.7
1921	15,818	12,774	11,716	10,880	80.8	91.7	85.2
Panama							
All Years	**125,979**	**99,381**	**90,486**	**68,450**	**78.9**	**91.0**	**68.9**
1914[3]	5,321	2,907	2,562	578	54.6	88.1	19.9
1915	25,010	16,890	14,918	10,829	67.5	88.3	64.1
1916	30,094	24,193	23,747	21,340	80.4	98.2	88.2
1917	16,676	14,088	13,262	11,126	84.5	94.1	79.0
1918	16,185	13,656	11,966	9,537	84.4	87.6	69.8
1919	15,307	13,490	11,812	8,313	88.1	87.6	61.6
1920	13,104	10,050	8,353	4,009	76.7	83.1	39.9
1921	4,282	4,107	3,866	2,718	95.9	94.1	66.2
Salvador							
All Years	**188,283**	**103,745**	**87,246**	**64,082**	**55.1**	**84.1**	**61.8**
1916[3]	8,422	2,696	2,354	1,511	32.0	87.3	56.0
1917	15,037	7,937	5,911	4,694	52.8	74.5	59.1
1918	44,328	26,580	21,094	14,044	60.0	79.4	52.8
1919	38,782	20,923	17,604	13,165	54.0	84.1	62.9
1920	36,172	19,710	17,180	13,033	54.5	87.2	66.1
1921	45,542	25,899	23,103	17,635	56.9	89.2	68.1

SOUTH AMERICA							
Brazil[4]							
All Years	**375,568**	**300,932**	**250,684**	**179,501**	**80.1**	**83.3**	**59.6**
1918[3]	10,490	6,922	5,894	4,208	66.0	85.1	60.8
1919	50,036	31,318	27,250	21,456	62.6	87.0	68.5
1920	102,474	77,432	68,207	56,923	75.6	88.1	73.5
1921	212,568	185,260	149,333	96,914	87.2	80.6	52.3
Colombia							
Both Years	**45,239**	**42,806**	**40,745**	**36,319**	**94.6**	**95.2**	**84.8**
1920[3]	6,863	6,043	5,694	4,353	88.1	94.2	72.0
1921	38,376	36,763	35,051	31,966	95.8	95.3	87.0
THE EAST							
Australia[4]							
Both Years	**38,224**	**2,193**	**2,075**	**1,609**	**5.7**	**94.6**	**73.4**
1920[3]	5,008	350	345	345	7.0	98.6	98.6
1921	33,216	1,843	1,730	1,264	5.5	93.9	68.6
Borneo							
1921[3]	**11,337**	**10,568**	**10,568**	**9,951**	**93.2**	**100.0**	**94.2**
Ceylon							
All Years	**384,099**	**372,587**	**319,698**	**297,973**	**97.0**	**85.8**	**80.0**
1916[3]	7,645	7,358	6,752	4,018	96.2	91.8	54.6
1917	42,828	41,613	35,675	33,440	97.2	85.7	80.4
1918	61,287	59,448	50,374	47,181	97.0[5]	84.7	79.4
1919	107,190	103,974	88,602	84,712	97.0[5]	85.2	81.5
1920	143,482	139,177	117,337	112,089	97.0[5]	84.3	80.5
1921	21,667	21,017	20,958	16,533	97.0[5]	99.7	78.7
China							
Both Years	**14,529**	**8,493**	**6,542**	**2,669**	**58.5**	**77.0**	**31.4**
1918[3]	12,504	7,556	5,694	2,519	60.4	75.4	33.3
1919[3]	2,025	937	848	150	46.3	90.5	16.0

TABLE 1—*Continued*

Division, Country, and State	Persons Examined	Persons Found Infected	Persons Given One Treatment[1]	Persons Given Two or More Treatments[2]	Per Cent Found Infected	Per Cent Given One Treatment	Per Cent Given Two or More Treatments
Egypt							
1914	**20,865**	**12,450**	**11,280**	**10,694**	**59.7**	**90.6**	**85.9**
Fiji							
Both Years	**6,624**	**5,975**	**5,780**	**5,551**	**90.2**	**96.7**	**92.9**
1917[3]	3,434	3,088	3,010	2,877	89.9	97.5	93.2
1918[3]	3,190	2,887	2,770	2,674	90.5	95.9	92.6
Seychelles							
All Years	**30,912**	**24,717**	**23,826**	**22,537**	**80.0**	**96.4**	**91.2**
1917[3]	8,111	7,778	7,600	6,635	95.9	97.7	85.3
1918	10,475	9,113	8,671	8,449	87.0	95.1	92.7
1919	10,801	6,924	6,702	6,612	64.1	96.8	95.5
1920[3]	1,525	902	853	841	59.1	94.6	93.2
Siam							
All Years	**172,390**	**161,678**	**155,490**	**2,247**	**93.8**	**96.2**	**2.6**
1918	31,298	24,018	18,122	3,183	76.7	75.5	13.3
1919	5,538	5,538	5,538	....	100.0	100.0	....
1920[3]	12,591	10,216	9,924	56	81.1	97.1	.5
1921	122,963	121,906	121,906	1,008	99.1	100.0	.8

---

[1] One treatment removes from 75 to 90 per cent of worms; see page 122.
[2] Two treatments remove from 88 to 95 per cent of worms; see page 122.
[3] Represents part-year effort only.
[4] States of Brazil and Australia not indicated separately.
[5] Treatment administered without preliminary diagnosis. Extensive study had previously demonstrated practically every person to be infected.

TABLE 2: *Expenditures of the International Health Board for the*

Activity, State, and Country	July 1, 1913 Dec. 31, 1914	1915	1916	1917
Grand Total........	**$157,731.08**	**$333,461.91**	**$506,087.48**	**$578,367.75**
Relief and Control of Hookworm Disease..	93,202.74	234,592.13	306,574.04	369,988.49
County Health Work.	....	....	....	182.95
Malaria Control.....	....	....	54,496.97	39,978.58
Yellow Fever Control	....	....	41,863.17	9,344.03
Tuberculosis in France............	....	....	....	51,856.24
Public Health Education............	....	....	9,256.74	12,376.63
Public Health Laboratory Service.......	....	....	....	....
Philippine Hospital Ship...............	....	25,000.00	....	....
Investigation of Sewage Disposal at Rural Homes......	....	....	664.39	5,359.11
Field Staff Salaries, Expenses, etc., not Prorated to Specific Budgets.......	15,351.20	9,877.95	4,687.45	9,232.30
Miscellaneous.......	15,138.35	15,057.65	27,628.35	18,191.76
Administration.......	34,038.79	48,934.18	60,916.37	61,857.66
Relief and Control of Hookworm Disease	**93,202.74**	**234,592.13**	**306,574.04**	**369,988.49**
Southern States[1]...	....	89,565.64	47,565.09	53.446.11
West Indies.......	38,707.33	52,393.83	88,845.12	87,764.12
Central America ...	19,552.54	55,379.47	88,123.29	98,483.25
South America.....	....	....	4,779.77	43,309.16
The East.........	19,466.66	37,253.19	77,260.77	84,912.45
Miscellaneous......	15,476.21	....	....	2,073.40
Southern States:[1]	....	**89,565.64**	**47,565.09**	**53,446.11**
Alabama..........	....	4,343.33	....	1,235.97
Arkansas..........	....	....	....	2,462.59
Georgia...........	....	22,822.59	....	2,436.95
Kentucky.........	....	9,766.49	4,866.63	2,200.00
Louisiana.........	....	529.38	1,813.19	1,278.66
Mississippi........	....	11,719.14	8,786.77	9,223.36
North Carolina....	....	3,026.99	3,282.34	8,548.71
South Carolina.....	....	5,872.56	5,643.52	7,967.22
Tennessee.........	....	11,889.72	5,797.57	6,585.02
Texas............	....	8,175.55	9,971.36	5,170.48

---

[1] In September, 1917, the hookworm work in the Southern States began to be absorbed in the
being longer in some states than in others, it was not possible to announce until the end of 1920
regular functions, responsibility for all efforts directed toward the relief and control of hookworm

Years 1913–1914 to 1921, Inclusive, Covering All Activities

1918	1919	1920	1921	Total
$1,121,862.86	**$1,436,355.00**	**$1,658,572.61**	**$1,701,185.96**	**$7,493,624.65**
457,953.94	509,091.99	621,520.98	457,486.99	3,050,411.30
2,494.53	2,439.25	8,182.77	167,765.19	181,064.69
26,489.29	34,965.08	133,929.02	150,551.39	440,410.33
46,639.17	94,526.42	139,757.40	239,057.53	571,187.72
433,030.43	602,775.78	518,013.51	359,540.31	1,965,216.27
36,642.82	38,367.71	68,373.54	89,094.44	254,111.88
....	....	....	16,109.70	16,109.70
12,500.00	6,500.00	....	....	44,000.00
4,288.01	778.60	....	....	11,090.11
5,345.82	21,701.87	26,074.89	38,936.95	131,208.43
23,034.17	46,901.63	51,248.30	59,652.90	256,853.11
73,444.68	78,306.67	91,472.20	122,990.56	571,961.11
457,953.94	**509,091.99**	**621,520.98**	**457,486.99**	**3,050,411.30**
87,284.58	110,860.17	136,019.06	15,730.39	540,471.04
57,800.06	48,457.24	61,857.73	85,541.60	521,367.03
113,545.86	111,684.19	98,303.98	77,920.73	662,993.31
97,031.00	157,555.86	206,486.22	150,422.24	659,584.25
97,932.47	80,014.39	113,472.55	121,805.46	632,117.94
4,359.97	520.14	5,381.44	6,066.57	33,877.73
87,284.58	**110,860.17**	**136,019.06**	**15,730.39**	**540,471.04**
5,922.09	5,283.74	17,256.71	....	34,041.84
2,784.41	....	....	....	5,247.00
5,418.95	4,604.21	4,525.39	....	39,808.09
2,064.97	1,978.40	16,599.03	....	37,475.52
1,317.93	1,370.18	....	....	6,309.34
9,427.52	15,773.21	20,709.72	....	75,639.72
15,775.89	13,924.04	10,463.00	....	55,020.97
13,870.12	14,754.86	17,210.63	....	65,318.91
6,642.20	10,201.59	13,533.22	....	54,649.32
9,362.85	22,380.20	14,723.99	....	69,784.43

programs of the rapidly developing county departments of health. The period of transition
that in all the states the county health departments would henceforth assume as one of their
and other soil-borne diseases.

TABLE 2: *Expenditures of the International Health Board for the*

ACTIVITY, STATE, AND COUNTRY	July 1, 1913 Dec. 31, 1914	1915	1916	1917
RELIEF AND CONTROL OF HOOKWORM DISEASE—*Continued*				
Southern States—*Cont'd*				
Virginia..........	$........	$6,622.97	$7,403.71	$6,337.15
Administration.....	....	....	....	....
County Dispensary Work in the South	....	4,796.92	....	....
Resurveys.........	....	....	....	....
West Indies:	**38,707.33**	**52,393.83**	**88,845.12**	**87,764.12**
Antigua...........	3,780.06	1,738.23	9,316.68	4,758.87
Barbados (survey)..	....	....	1,651.31	....
British Guiana[1] ...	9,711.36	13,300.06	18,554.45	19,231.23
Cayman Islands (survey)........	....	....	....	1,795.16
Dutch Guiana[1]	....	3,260.93	11,672.46	19,168.40
Grenada..........	7,003.76	10,593.37	10,154.65	7,778.80
Jamaica..........	....	....	....	....
Porto Rico........	....	....	....	....
Santo Domingo (survey)........	....	....	....	....
St. Lucia.........	4,742.30	6,048.76	6,295.20	6,865.60
St. Vincent........	4,335.18	4,834.00	6,825.15	9,384.18
Tobago (survey)...	....	....	....	1,072.22
Trinidad..........	9,134.67	8,242.19	15,104.04	10,898.37
Administration.....	....	4,376.29	9,271.18	6,811.29
Central America:	**19,552.54**	**55,379.47**	**88,123.29**	**98,483.25**
British Honduras (survey)	....	....	4,273.47	....
Costa Rica........	9,174.60	16,913.06	18,089.98	21,752.31
Guatemala........	185.53	10,432.69	11,954.29	13,346.70
Nicaragua........	375.00	7,587.80	18,430.69	19,418.74
Panama..........	9,817.41	18,828.55	24,449.62	22,881.75
Salvador..........	....	....	10,925.24	21,083.75
Administration.....	....	1,617.37	....	....
South America:	....	....	**4,779.77**	**43,309.16**
Brazil............	....	....	4,779.77	43,309.16
Colombia.........	....	....	....	....

---

[1] For administrative reasons British and Dutch Guiana, although on

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$5,947.86	$10,012.42	$14,965.17	$........	$51,289.28
8,749.79	10,577.32	6,032.20	....	25,359.31
....	....	....	....	4,796.92
....	....	....	15,730.39	15,730.39
57,800.06	**48,457.24**	**61,857.73**	**85,541.60**	**521,367.03**
....	....	....	....	19,593.84
....	....	....	....	1,651.31
16,504.11	9,984.28	486.37	1,281.02	89,052.88
....	....	....	....	1,795.16
4,389.11	613.23	570.34	12,917.66	52,592.13
1,833.74	....	....	....	37,364.32
3,937.85	9,832.48	18,400.09	16,949.24	49,119.66
....	....	7,823.35	18,290.86	26,114.21
....	....	1,077.07	....	1,077.07
8,152.28	8,109.32	11,444.57	8,545.88	60,203.91
6,383.25	....	....	17,489.50	49,251.26
....	....	....	....	1,072.22
12,301.48	15,293.43	16,016.71	....	86,990.89
4,298.24	4,624.50	6,039.23	10,067.44	45,488.17
113,545.86	**111,684.19**	**98,303.98**	**77,920.73**	**662,993.31**
....	....	....	....	4,273.47
21,330.40	20,492.01	20,219.60	14,061.66	142,033.62
20,816.27	19,514.73	17,126.43	15,362.58	108,739.22
22,454.30	26,164.44	18,745.12	21,479.43	134,655.52
24,312.26	18,565.05	20,061.02	23,496.22	162,411.88
17,573.90	17,162.10	14,973.80	3,520.84	85,239.63
7,058.73	9,785.86	7,178.01	....	25,639.97
97,031.00	**157,555.86**	**206,486.22**	**150,422.24**	**659,584.25**
97,031.00	155,430.38	193,560.95	131,787.27	625,898.53
....	2,125.48	12,925.27	18,634.97	33,685.72

the mainland of South America, are considered West Indian colonies.

TABLE 2: *Expenditures of the International Health Board for the*

ACTIVITY, STATE, AND COUNTRY	July 1, 1913 Dec. 31, 1914	1915	1916	1917
RELIEF AND CONTROL OF HOOKWORM DISEASE *Continued*				
The East:	**$19,466.66**	**$37,253.19**	**$77,260.77**	**$84,912.45**
Uncinariasis Commission to Orient	....	15,504.31	19,406.36	16,572.64
Australia	....	....	....	....
British North Borneo	....	....	....	....
British Solomon Islands (survey)	....	....	....	....
Ceylon	....	2,073.07	21,585.84	30,340.00
China	....	....	....	3,981.58
Egypt	19,466.66	6,608.12	....	....
Fiji	....	....	3,386.37	5,776.92
Java (survey)	....	....	327.66	....
India (survey)	....	....	....	....
Mauritius (survey)	....	....	....	....
Papua and Queensland	....	....	....	4,074.84
Seychelles Islands	....	589.06	3,933.29	7,409.69
Siam	....	....	6,147.52	6,458.57
Administration	....	12,478.63	22,473.73	10,298.21
Miscellaneous:	**15,476.21**	....	....	**2,073.40**
Research in Life History of Hookworm Eggs and Larvae	....	....	....	....
Study of Methods of Diagnosing Hookworm Disease	....	....	....	....
Conferences, Health Officers of Southern States	....	....	....	2,073.40
Motion Picture Film on Hookworm Disease	....	....	....	....
Lecture Charts	....	....	....	....
Salvador, Portable House and Office	....	....	....	....
Salvador, Loss from Earthquake	....	....	....	....
Thymol	15,476.21	....	....	....
Dutch Guiana, Care and Storage of Motor Boat and Supplies	....	....	....	....

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$97,932.47	**$80,014.39**	**$113,472.55**	**$121,805.46**	**$632,117.94**
....	....	....	....	51,483.31
....	15,902.95	35,417.41	39,912.29	91,232.65
....	....	3,106.23	7,440.10	10,546.33
....	....	....	1,378.85	1,378.85
36,041.44	32,497.87	33,779.28	23,689.34	180,006.84
12,400.87	12,187.58	....	....	28,570.03
....	....	....	....	26,074.78
5,579.84	....	....	498.64	15,241.77
....	....	....	....	327.66
....	....	7,810.00	12,496.30	20,306.30
....	....	5,688.56	....	5,688.56
18,633.50	....	....	....	22,708.34
8,089.06	8,291.90	4,643.03	....	32,956.03
13,042.15	7,514.66	15,850.03	18,429.18	67,442.11
4,145.61	3,619.43	7,178.01	17,960.76	78,154.38
4,359.97	**520.14**	**5,381.44**	**6,066.57**	**33,877.73**
....	....	....	3,618.83	3,618.83
....	43.95	....	500.00	543.95
2,990.76	....	2,488.71	....	7,552.87
....	....	2,817.73	1,584.74	4,402.47
17.40	....	....	....	17.40
945.35	476.19	75.00	....	1,496.54
406.46	....	....	....	406.46
....	....	....	....	15,476.21
....	....	....	363.00	363.00

TABLE 2: *Expenditures of the International Health Board for the*

ACTIVITY, STATE, AND COUNTRY	July 1, 1913 Dec.31,1914	1915	1916	1917
COUNTY HEALTH WORK[1]	$........	$........	$........	$182.95
Alabama	....	....	....	....
Florida	....	....	....	....
Georgia	....	....	....	....
Kansas	....	....	....	....
Kentucky	....	....	....	....
Louisiana	....	....	....	....
Maryland	....	....	....	182.95
Mississippi	....	....	....	....
Missouri	....	....	....	....
New Mexico	....	....	....	....
North Carolina	....	....	....	....
South Carolina	....	....	....	....
Tennessee	....	....	....	....
Texas	....	....	....	....
Virginia	....	....	....	....
West Virginia	....	....	....	....
Administration	....	....	....	....
MALARIA CONTROL	....	....	54,496.97	39,978.58
Southern States:				
Alabama	....	....	....	....
Arkansas	....	....	11,104.58	4,276.23
Georgia	....	....	....	....
Louisiana	....	....	....	....
Mississippi	....	....	43,392.39	35,702.35
Missouri	....	....	....	....
North Carolina	....	....	....	....
South Carolina	....	....	....	....
Tennessee	....	....	....	....
Texas	....	....	....	....
Virginia	....	....	....	....
Administration	....	....	....	....
Foreign Countries:				
Ecuador	....	....	....	....
Argentina	....	....	....	....
Brazil	....	....	....	....
Nicaragua	....	....	....	....
Porto Rico	....	....	....	....
Miscellaneous:				
Conference of Malaria Workers	....	....	....	....

---

[1] In September, 1917, the hookworm work in the Southern States began to be absorbed in the being longer in some states than in others, it was not possible to announce until the end of 1920 regular functions, responsibility for all efforts directed toward the relief and control of hookworm

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$2,494.53	**$2,439.25**	**$8,182.77**	**$167,765.19**	**$181,064.69**
....	....	....	18,231.35	18,231.35
....	....	....	237.75	237.75
....	....	....	4,338.17	4,338.17
....	....	4,494.00	6,316.99	10,810.99
....	....	......	16,316.41	16,316.41
....	....	....	5,618.28	5,618.28
2,494.53	2,264.25	....	1,762.59	6,704.32
....	....	....	15,652.72	15,652.72
....	....	....	600.00	600.00
....	....	957.04	10,837.52	11,794.56
....	....	....	14,413.38	14,413.38
....	....	....	17,651.97	17,651.97
....	....	....	14,686.42	14,686.42
....	....	....	12,765.65	12,765.64
....	....	....	13,972.74	13,972.74
....	175.00	2,731.73	4,164.56	7,071.29
....	....	....	10,198.70	10,198.70
26,489.29	**34,965.08**	**133,929.02**	**150,551.39**	**440,410.33**
....	....	8,906.92	7,650.06	16,556.98
4,749.02	13,505.66	7,048.90	4,777.15	45,461.54
....	....	1,230.86	....	1,230.86
....	....	30,699.94	22,929.88	53,629.82
21,740.27	21,167.37	27,537.43	21,185.61	170,725.42
....	....	....	1,471.37	1,471.37
....	....	7,526.13	18,676.30	26,202.43
....	....	13,942.74	13,321.90	27,264.64
....	....	1,969.94	1,512.56	3,482.50
....	....	11,472.34	10,347.23	21,819.57
....	....	5,284.84	831.65	6,116.49
....	....	6,032.20	10,198.68	16,230.88
....	....	4,595.59	....	4,595.59
....	....	....	5,661.02	5,661.02
....	292.05	....	....	292.05
....	....	425.66	6,662.51	7,088.17
....	....	5,445.18	24,914.84	30,360.02
....	....	1,810.35	245.00	2,055.35

---

programs of the rapidly developing county departments of health. The period of transition that in all the states the county health departments would henceforth assume as one of their and other soil-borne diseases.

TABLE 2: *Expenditures of the International Health Board for the*

Activity, State, and Country	July 1, 1913 Dec. 31, 1914	1915	1916	1917
Malaria Control—*Continued*				
Miscellaneous—*Cont'd*				
Study of Source of Blood Meals of Anopheles Mosquitoes	$........	$........	$........	$........
Yellow Fever Control	....	....	41,863.17	9,344.03
Yellow Fever Commission	....	....	41,863.17	7,727.74
East Coast of Brazil and Caribbean	....	....	....	1,616.29
Brazil	....	....	....	....
Ecuador	....	....	....	....
Guatemala	....	....	....	....
Mexico and Central America	....	....	....	....
Peru	....	....	....	....
Salvador	....	....	....	....
Epidemic Work	....	....	....	....
Tuberculosis in France	....	....	....	51,856.24
Inauguration of Work	....	....	....	18,671.74
Department of Organization	....	....	....	....
Public Health Division	....	....	....	....
Central Administration	....	....	....	18,292.10
Educational Division	....	....	....	5,316.39
Medical Division	....	....	....	9,576.01
Contingent Fund	....	....	....	....
Public Health Education	....	....	9,256.74	12,376.63
Department of Hygiene, São Paulo	....	....	....	179.59
Institute of Hygiene, Czechoslovakia	....	....	....	....
Public Health Institutes	....	....	....	....
Fellowships	....	....	....	971.85
Adviser in Medical Education	....	....	....	11,225.19

Years 1913–1914 to 1921, Inclusive, Covering All Activities—Cont'd

1918	1919	1920	1921	Total
$........	$........	$........	$165.63	$165.63
46,639.17	**94,526.42**	**139,757.40**	**239,057.53**	**571,187.72**
....	44,271.12	83,717.13	....	177,579.16
2,897.97	....	....	....	4,514.26
....	....	....	461.30	461.30
29,473.98	48,396.77	28,574.98	1,698.06	108,143.79
14,267.22	967.82	....	....	15,235.04
....	....	....	156,562.54	156,562.54
....	....	....	80,335.63	80,335.63
....	890.71	3,926.26	....	4,816.97
....	....	23,539.03	....	23,539.03
433,030.43	**602,775.78**	**518,013.51**	**359,540.31**	**1,965,216.27**
....	....	....	....	18,671.74
....	....	139,364.76	47,281.28	186,646.04
....	....	76,191.46	101,473.08	177,664.54
80,037.65	72,394.12	86,310.57	89,575.04	346,609.48
85,755.19	141,053.34	135,920.64	79,839.90	447,885.46
267,237.59	389,328.32	80,226.08	40,621.01	786,989.01
....	....	....	750.00	750.00
36,642.82	**38,367.71**	**68,373.54**	**89,094.44**	**254,111.88**
32,788.84	23,582.57	29,929.01	24,727.16	111,207.17
....	....	....	204.51	204.51
....	....	....	3,466.64	3,466.64
2,353.98	13,118.47	38,409.84	60,696.13	115,550.27
1,500.00	1,666.67	....	....	14,391.86

INDEX

PAGE

A. quadrimaculatus (Mosquito)............................ 105

Ackert, Dr. J. E.......................................66, 81

Alabama...........ix, x, 17, 18, 52, 56, 58, 93, 97, 110, 113, 118, 120
  See also Names of counties.

Alagoas (City) Brazil..................................... 13

Alagoas (State) Brazil..................................viii, 27

American Red Cross.. 113

Ancylostoma, *see* Hookworms.

Ancylostomiasis, *see* Hookworm Disease.

Animals:
  Treatment of dogs with carbon tetrachloride.................. 48
  Pigs as carriers of hookworm disease........................ 82
  Use in mosquito control..................................... 104

Anopheles (Mosquito)...............................93, 98, 104

Anti-Hookworm Campaigns in Southern India by J. F. Caius, K. S. Mhaskar, and J. F. Kendrick........................ 66

Anti-Mosquito Measures, *see* Malaria Control; Yellow Fever.

Antitoxin, *see* Toxin-Antitoxin (for diphtheria).

Arkansas...x, 17, 93, 97
  See also Names of towns.

Ascaridol... 47

Assam... 45

Augusta, Georgia.. 106

Augustine, D. L...................................62, 66, 81

Australia:
  Progress of the five-year scheme under new Ministry of Health..42, 45
  Hookworm control operations..........................72, 75–76
  Also..viii, xi, xii, 48
  See also Names of towns, states, and territories.

Austria... 58

Azevedo, Dr. Paes de...................................... viii

Baermann Apparatus, *see* Hookworms.

Bahia (City) Brazil....................................... 13

Bahia (State) Brazil...................................... 13

Bailey, Dr. C. A..................................ix, xi, 110

Baldwin County, Alabama................................... 120

Bangkok, Siam... 42

Barnes, Dr. M. E.. ix

Bass, Dr. C. C.....................x, 21, 62, 66, 99, note 103

PAGE

Bayous, *see* Malaria Control.

Belgian Congo 14

Belize, British Honduras 11

Bell County, Kentucky 119

Bengal 91
  See also Darjeeling (District) Bengal.

Beta-naphthol 47

Biggs, Dr. H. M. vii

Blount County, Tennessee 118

Bolivar County, Mississippi 100

Borneo, *see* British North Borneo.

Botello, T. F. xi

Boyd, Dr. M. F. .... x, 105

Brazil:
  Center of yellow fever infection 12–13
  National department of health 13, 59–60
  Resurveys for hookworm infection 33–35
  Development of county health organization 35–36
  Fellowships 52
  Also .... viii, xi, xii, 2, 28, 46, 47, 91, 121
    See also Governor's Island, Brazil; also Names of towns, cities, and states.

Brisbane, Queensland 75

British Guiana 36

British Honduras:
  Hookworm control 45–46
  Hookworm infection survey 77–78
  Also .... xi, 9, 10, 11

British North Borneo .... viii, 41

British Solomon Islands .... ix, 27, 72

Bruno, Dr. Alexander xi

Buck, C. E. x

Buckingham Mills (Madras) 67, 71–72

Buenaventura, Colombia 3

Buenos Aires, Nicaragua 98

Bull, Dr. C. G. 103

Bullard, Texas 94

Burres, Dr. W. T. xii

Buttrick, Wallace vii

Caius, Dr. J. F. 66

Caldwell, Dr. B. W. .... xi, 109

Caldwell, Dr. F. C. .... ix, 48, 87

Calhoun County, Alabama 98

Callao, Peru 2, 3, 6

PAGE

Campeche, Mexico.................................... 11

Canada:
  Fellowships.................................... 52

Canal Zone.................................... 39

Cannanore Jail, Madras....................................67, 71

Carbon Tetrachloride.................................... 48

Carnatic Mills (Madras)....................................67, 71–72

Carter, Dr. H. R.................................... x

Central America....................................xi, 2, 6, 12, 15, 39, 58
  See also Names of countries.

Ceylon:
  Public health policy.................................... 42
  Fellowships.................................... 52
  Also....................................ix, xii, 90

Chagas, Dr. Carlos.................................... 59

Charleville—Dalby Area, Queensland....................................72, 75

Chenopodium, *see* Oil of Chenopodium.

Chickens as Carriers of Hookworm Disease.................................... 82

Children:
  Hookworm surveys among children in Southern States........28–31
  Percentage of hookworm infection in Queensland.............. 75
  Hookworm infection rates in Siam....................................76–77
  Hookworm infection rates in Jamaica.................................... 79
  Dosage of quinine in malaria control.................................... 100
  Nutritional work in schools....................................117–118
  Scarlet fever at Santa Fé, New Mexico....................................120
  See also Hemoglobin.

China.................................... xii

Chingleput Town Reformatory, Madras.................................... 71

Clarke, J. L.................................... x

Clermont, Queensland.................................... 75

Cloncurry—Hughenden Area, Queensland.................................... 72

Coimbatore (District) Madras.................................... 67

Coimbatore Jail, Madras.................................... 71

Colombia:
  Fellowships.................................... 52
  Percentage of hookworm infection.................................... 78
  Also....................................ix, 13, 48
  See also Buenaventura, Colombia.

Commission for Prevention of Tuberculosis in France:
  Résumé of work....................................22, 25–26
  Dispensaries and sanatoria....................................25–26
  Expenditures....................................136–137, 144–145

Connor, Dr. M. E....................................xi, 10, 62, 109

Cort, Dr. W. W....................................36, 46, 48, 49, 62, 66, 81, 86

Cosamaloapan, Mexico.................................... 11

PAGE
Costa Rica:
  Work of hookworm control assumed by government..........39–40
  Fellowships.......... 52
  Also..........ix, 48
County Health Work:
  Malaria control..........18, 21, 97–98
  Development of organization in Brazil..........35–36
  Development of departments in the Southern States.......... 55
  Personnel and budgets..........56, 114
  Experiment in county health administration, Washington County, Maryland..........56–57
  Field investigations in the Southern States.......... 112
  Appropriations for co-operative projects..........112–113
  Plan of work..........113–114
  Public health nurses..........114, 117
  Newer activities..........117–118
  Nutritional work in schools..........117–118
  Results of co-operative projects..........118–120
  Table showing annual increase in funds.......... 121
  Stimulates interest in foreign countries.......... 121
  Expenditures.......... 136–137, 142–143
Covington, Dr. P. W..........ix, x
Crossett, Arkansas.......... 97
Crowell, F. E.......... xi
Culex (Mosquito).......... 93
Czechoslovakia:
  Fellowships..........52
  Commission to study public health administration..........60–61
  Plans and procedure of the Ministry of Health..........60–61
  Also..........xii, 1, 50, 56, 121

Dahomey, Africa.......... 14
Dalby, Queensland, *see* Charleville—Dalby Area, Queensland.
Darjeeling (District) Bengal 67
Darling, Dr. S. T..........xii, 4, 62
Darwin, Northern Territory.......... 72
Davies, Dr. W. H.......... xi
Daviess County, Kentucky..........118–119
Dermott, Arkansas.......... 97
Dershimer, Dr. F. W.......... ix
Devarshola Estate, Madras.......... 71
Dindigul, Madras..........67, 69
Diphtheria Control..........117, 119–120
Dispensaries..........42, 60
  See also Commission for Prevention of Tuberculosis in France.
Docherty, Dr. J. F.......... x
Dogs, *see* Animals.

PAGE

DUTCH GUIANA:
  Government support of public health........................ 38
  Percentage of hookworm infection........................... 78
  Also..ix, 36
DYSENTERY...30, 31

ECUADOR...3, 6, 109
    See also GUAYAQUIL, ECUADOR.
EGYPT:
  Government resuming operations............................. 45
ELMENDORF, DR. J. E., JR..................................... ix
EMBREE, E. R... vii
EMERALD, QUEENSLAND, *see* LONGREACH—EMERALD AREA, QUEENSLAND.
ENGLAND.. 1, 2
ESPIRITO SANTO, BRAZIL..................................viii, 27

FAR EAST:
  Promotion of public health.............................41–45
    See also Names of countries.
FARMVILLE, NORTH CAROLINA.................................... 117
FEDERAL DISTRICT, BRAZIL:
  Resurveys for hookworm infection.......................33–35
  New health divisions....................................... 59
FELLOWSHIPS AND SCHOLARSHIPS.............................51–52
FERRELL, DR. J. A.......................................viii, 62
FIJI ISLANDS:
  Progress of public health work............................. 41
FISH:
  In yellow fever control..................5–6, 10, 106, 109–110
  Top minnows in malaria control...16, 21, 22, 93, 98, 103–104, 106, 110
  Family Poeciliidae..................................109–110, 111
FISHER, DR. A. C... 30
FLEXNER, DR. SIMON... vii
FLORIDA...56, 113
FOSDICK, R. B.. vii
FRANCE.......................................xi, 1, 2, 52, 121
    See also COMMISSION FOR PREVENTION OF TUBERCULOSIS IN FRANCE;
      also Names of cities.

GAGE, E. H... x
Gambusia affinis (TOP MINNOW), *see* FISH.
GAMETES (IN BLOOD)... 103
GANN, DR. THOMAS.....................................45, 46, 77
GATES, F. T.. vii
GEARY COUNTY, KANSAS... 119
GEIGER, DR. J. C... 106
GEORGIA.........................52, 56, 93, 103, note 113, 120
    See also AUGUSTA, GEORGIA.

PAGE

German New Guinea, *see* Late German New Guinea.
Gilbert, F. P. x
Gladstell, Texas 97
Gold Coast 14
Gorgas, Sur.-Gen. W. C. 3
Governor's Island, Brazil 86
Grant, Dr. J. B. xii
Green, H. W. x
Greenville, North Carolina 117
Greenwood County, South Carolina 118
Gregg, Dr. Alan .... viii, 63
Grogan, G. L. 94
Guatemala .... ix, xi, 9, 10, 12, 52, 59, 110
Guayaquil, Ecuador 3, 5, 6, 10, 14, 106
Guiteras, Dr. Juan .... xi, 63
Gunn, S. M. xii

Hackett, Dr. L. W. .... viii, xii, 77
Hall, Dr. M. C. 48
Hamburg, Arkansas 97
Hammond Island, Queensland 75
Hampton, Dr. G. G. ix
Hanson, Dr. Henry 5, 15, 106, 109
Harlan County, Kentucky 118–119
Harrison, Dr. A. P. .... x, 63
Harvard University—School of Public Health 50–51
Hastings, L. G. x
Hausheer, Dr. W. C. ix
Health Officers' Training Courses 52
Hegner, R. W. 63
Heiser, Dr. V. G. .... viii, xii, 45
Hemoglobin:
  Average index among coolies 71, 72
  Average index among prisoners in Madras jails 71
  Average index in Papua 76
  Index among children in Siam 77
  Among children in Jamaica 79
Hildebrand, S. F. 106
Hill, Dr. R. B. ix
Hinds County, Mississippi 106
Honduras .... xi, 9, 10, 12, 27
Hookworm Disease:
  Relation to county health work 55

PAGE

Hookworm Disease, Diagnosis:
- Stool examination technique ... 47
- Willis salt-flotation method ... 48, 90
- Differentiation of hookworm and strongyloid larvae ... 48, 91–92
- Lane levitation method ... 90–91

Hookworm Disease, Infection:
- Rates in Jamaica ... 38, 78–79
- Rates in Madras presidency ... 67–72
- Affected by jail life ... 70
- Hemoglobin indices ... 70, 71, 72, 76, 77, 79
- Incidence in Australia ... 72, 75–76
- Among children in Queensland ... 75
- Rates in Papua ... 75–76
- Rates in Siam ... 76–77
- Rates among prisoners in Siam ... 77
- Rates in Dutch Guiana ... 78
- Rates in Porto Rico ... 78
- Rates in Colombia ... 78
- Pigs and chickens as carriers ... 82
- Epidemiologic study in Trinidad ... 82, 85
- Among the San Blas Indians ... 87–88
- Severity estimated by counting ova in microscopic field ... 91

Hookworm Disease, Relief and Control:
- In Richmond County, Virginia ... 28–30
- Resurveys ... 30–32, 120
- Work of Board in Southern States completed ... 32–33
- Resurvey in Brazil ... 33–35
- Government appropriation in Panama ... 39
- Government control in Central America ... 39–41
- Government aid in the Far East ... 41–42
- Miscellaneous government and voluntary effort ... 45–46
- Field studies ... 47–49
- In Madras presidency ... 68–72
- Results in Sumatra ... 79–80
- Economy in field operations ... 86
- Simplified plan of procedure ... 86–87
- Tables showing examinations and treatments ... 124–134
- Expenditures ... 136–141

Hookworm Disease, Treatment:
- Value of mass treatment ... 46–47
- Further tests with anthelmintics ... 47–48
- Carbon tetrachloride given to dogs ... 48
- Results in Jamaica ... 78–79
- Plans for heavily and lightly infected areas ... 86–87
- Mass treatment in absence of latrines ... 87
  - *See also* Names of drugs.

Hookworms:
- Studies on eggs and larvae in the soil ... 48, 81–82, 85–89
- Differentiation of hookworm and strongyloid larvae ... 48, 91–92
- Action of sea-water on larvae ... 48–49
- *Necator suillus* ... 82
- Necators (*Necator americanus*) ... 68, 69

PAGE

Hookworms—*continued*
  Migration of larvae in soil 85
  Position of larvae in the soil 85–86
  Effect of salt on viability of eggs and larvae 87–88
  Modified Baermann apparatus for recovering larvae from the soil 48, 88–89

Howard, Dr. H. H. .... viii, xii, 21, 106

Hughenden, Queensland, *see* Cloncurry—Hughenden Area, Queensland.

Hulse, F. E. x

Hydrick, Dr. J. L. xi

Impounding of Water, *see* Malaria Control.

India .... ix, 47, 48, 106
  See also Names of places.

Indian Research Fund Association .... note 47, 67

Indiana .... ix, 113

International Health Board:
  Survey of activities 1
  Yellow fever control 1–15, 106, 109–110
  Malaria control 15–22, 93–105
  Résumé of tuberculosis work in France 22, 25–26
  Hookworm control 26–49, 67–92
  Termination of hookworm work in Southern States 32–33
  Rural sanitation in Brazil 35
  Sanitation in the West Indies 36–39
  Public health in Central America 39–41
  Work in the Far East 41–45, 76–77, 79–80
  Modification in field procedures 46–47
  Development of schools of hygiene 49–51
  Fellowships 51–52
  Extension courses in public health 52
  County health work 55–57, 112–121
  Contributions to county health budgets 56
  Public health laboratories 57–59
  Assistance to nurses' training school in Rio de Janeiro 59–60
  Institute of public health at Prague 60–61
  Reports and publications issued 61–64
  Field operations 86–87
  Anti-mosquito measures 93, 99, 106–111
  Statistical tables 122–134
  Expenditures 136–147

Investigations on the Control of Hookworm Disease, by W. W. Cort, D. L. Augustine, J. E. Ackert, F. K. Payne, and G. C. Payne 66

Iquitos, Peru, *see* Yquitos, Peru.

Italy 2

Jacarepagua, Brazil 86

Jacocks, Dr. W. P. ix

PAGE

JAILS AND PENITENTIARIES, *see* CANNANORE JAIL, MADRAS; COIMBATORE JAIL, MADRAS; HOOKWORM DISEASE, INFECTION; PARCHMAN PENITENTIARY, SUNFLOWER COUNTY, MISSISSIPPI; TRICHINOPOLY JAIL, MADRAS.

JALAP POWDER.......... 48

JAMAICA:
  Popular interest in public health.......... 38
  Appointment of health officer.......... 38–39
  Average hookworm infection rates.......... 78–79
  Also.......... ix, 27, 36, 48

JANNEY, DR. J. H.......... viii, xi, xii

JOHNS HOPKINS UNIVERSITY—SCHOOL OF HYGIENE AND PUBLIC HEALTH.......... xii, 50, 56, 81

JOHNSON, E. B.......... x

JOHNSON, H. A.......... x, xii

JORDAN, E. O.......... vii

KALYANAPANADAL TEA ESTATE, MADRAS.......... 67

KANSAS.......... ix, 56, note 113
  See also GEARY COUNTY, KANSAS.

KENDRICK, DR. J. F.......... ix, 47, 66, 67

KENTUCKY.......... ix, 56, note 113, 118, 120
  See also Names of counties.

KLIGLER, I. J.......... 67

LABORATORIES:
  Relation to public health administration.......... 57
  In Europe.......... 58
  In the Southern States.......... 58

LABORATORY TECHNIQUE, *see* HOOKWORM DISEASE, DIAGNOSIS.

LAKE CHARLES, LOUISIANA.......... 94

LAKE VILLAGE, ARKANSAS.......... 97

LAMBAYEQUE (DEPARTMENT) PERU.......... 4

LAMBAYEQUE (TOWN) PERU.......... 11

LAMBERT, DR. S. M.......... viii, ix, 63, 75

LAMPANG, SIAM.......... 76

LANE, COL. SIR CLAYTON.......... 45, 47, 67, 90, 91

LANE LEVITATION METHOD, *see* HOOKWORM DISEASE, DIAGNOSIS.

LANZA, DR. A. J.......... xi, 42

LA PUEBLA—RIVAS, NICARAGUA.......... 98–99, 109–110

LATE GERMAN NEW GUINEA.......... viii, 27

LATRINES:
  In Richmond County, Virginia.......... 29–30
  In Federal District, Brazil.......... 33–35
  In Trinidad.......... 37
  In Fiji.......... 41

PAGE

LATRINES—*continued*
  In British Honduras....46, 77
  In the Southern States....112, 118
  Also....86, 87
LEACH, DR. C. N....viii, ix, xii
LE PRINCE, J. A....63, 109
Leptospira icteroides (YELLOW FEVER BACILLI)....14
LIBERTAD, PERU....4, 6
LIMA, PERU....109
LIONEL TOWN HOSPITAL, JAMAICA....78
LONGLEY, F. F....xi, 42
LONGREACH—EMERALD AREA, QUEENSLAND....72, 75
LONOKE, ARKANSAS....106
LOUISIANA....x, 56, 93, 113
    See also LAKE CHARLES, LOUISIANA; MOUND, LOUISIANA.
LOWER PARÁ (DUTCH GUIANA)....38
LOWER SURINAM (DUTCH GUIANA)....38
LYONS, FRANCE....58
LYSTER, DR. T. C....xi

MCKAY, DR. A. L....ix
MADRAS (CITY) INDIA:
  Percentage of hookworm infection....67–68, 71–72
MADRAS (PRESIDENCY) INDIA:
  Government aid in hookworm control....41–42
  Campaign against hookworm disease....67
  Percentage of hookworm infection....67–72
    See also Names of towns and cities.
MADURA, MADRAS....69
MAGOON, E. H....x
MAHARAT, SIAM....76
MALABAR, MADRAS....69, 71
MALARIA CONTROL:
  Results of field experiments....15–16
  Use of top minnow....16, 21, 22, 93, 98, 103–104, 106, 110
  Per capita cost....16
  State budgets....16–17
  Intensive demonstrations and municipal governments....18
  Quinine treatment....18, 21, 22
  County as the unit of operations....18, 21
  Field experiments continued....21–22
  Tests in screening of houses....22
  Mosquito control in Nicaragua and Porto Rico....22
  In Trinidad....37
  Anti-mosquito measures in Southern States....93–94, 97
  Results and costs....93–94
  Economic value....94
  Legislative appropriations....97

PAGE

MALARIA CONTROL—*continued*
  In Arkansas........ 97
  In Alabama........ 97, 98
  Work of county health departments........ 97–98, 117
  Cost of fish control........ 98
  Anti-mosquito measures under tropical conditions........ 98–99
  Results and per capita cost in La Puebla-Rivas, Nicaragua........ 99
  Sterilization of carriers........ 99–103
  Determining carriers........ 103
  Field studies at Mound, Louisiana........ 103–104
  By impounding water in bayous........ 104
  Survey in Missouri........ 105
  Use of fish as anti-mosquito measure........ 106, 110–111
  Use of fish in Rivas, Nicaragua........ 109–110
  Use of fish in Southern States........ 110
  Expenditures........ 136–137, 142–144
  Also........ x
    See also FISH; QUININE.

MANAGUA, NICARAGUA........ 109

MANANTODDY ESTATE, MADRAS........ 71

MANZANILLO, MEXICO........ 12

MARSHALL, DR. H. K........ xi

MARYLAND........ 56, 113
    See also WASHINGTON COUNTY, MARYLAND.

MARYLAND STATE DEPARTMENT OF HEALTH........ 56

MASS TREATMENT, *see* HOOKWORM DISEASE, TREATMENT.

MAURITIUS:
  Government control in hookworm measures........ 27, 41

MAYA CITIES, YUCATAN........ 9

MAZATLÁN, MEXICO........ 2, 9, 12

MERIDA, YUCATAN........ 6, 9, 11, 109

MEXICO:
  Fellowships........ 52
  Also........ xi, xii, 2, 6, 9, 10, 12, 14, 58, 59
    See also Names of towns and states.

MEYER, E. C........ 61

MHASKAR, DR. K. S........ 47, 66, 91

MICHIGAN........ 52

MIELDAZIS, J. J........ x, xii

MIGRATION OF HOOKWORM LARVAE, *see* HOOKWORMS.

MILK SUPPLY........ 118

MILLER, DR. F. A........ ix

MINAS GERAES (STATE) BRAZIL........ 121

MISSISSIPPI:
  Malaria control in Bolivar and Sunflower counties........ 21–22
  Also........ x, 17, 21, 56, 58, 93, 97, 103, note 113
    See also PARCHMAN PENITENTIARY, SUNFLOWER COUNTY, MISSISSIPPI; RULEVILLE, SUNFLOWER COUNTY, MISSISSIPPI; *also* Names of counties.

PAGE
MISSISSIPPI DEPARTMENT OF HEALTH 99
MISSOURI:
  Malaria survey 105
  Also .... x, 17, 56, 97, 113
MISSOURI STATE BOARD OF HEALTH 105
MOLLOY, DR. D. M .... ix, xi, 48, 90, 109
MONROE, DR. W. M .... xi, xii
MONTGOMERY COUNTY, TENNESSEE 117, 118, 119
MONTPELLIER, FRANCE 58
MORGAN COUNTY, ALABAMA 98
MOSQUITO CONTROL, *see* MALARIA CONTROL; YELLOW FEVER.
MOUND, LOUISIANA:
  Studies and experiments in malaria control 22, 103
MUDIS TEA ESTATE, MADRAS 67, 72
MUENCH, DR. HUGO, JR x

NANCY, FRANCE 58
NATAL, BRAZIL 13
NATIONAL MALARIA COMMITTEE 103
NECATORS, *see* HOOKWORMS.
NEGAPATAM, MADRAS 67, 69
NEW GUINEA, *see* LATE GERMAN NEW GUINEA.
NEW JERSEY AGRICULTURAL EXPERIMENT STATION 106
NEW MEXICO .... x, 56, note 113
    See also SANTA FÉ, NEW MEXICO.
NEW SOUTH WALES 27, 72
NEW YORK STATE 52
NICARAGUA:
  Tests in mosquito control 22
  Establishment of national department of health 40
  Fellowships 52
  Also .... ix, x, xi, 9, 10, 12, 48, 58
    See also Names of towns.
NIGERIA, *see* NORTHERN NIGERIA; SOUTHERN NIGERIA.
NILGIRI TEA ESTATES, *see* WYNAAD—NILGIRI TEA ESTATES, MADRAS.
NOGUCHI, DR. HIDEYO .... xi, 14, 63
NORTH CAROLINA .... x, 56, 93, 113, 120
    See also FARMVILLE, NORTH CAROLINA; GREENVILLE, NORTH CAROLINA; PITT COUNTY HEALTH DEPARTMENT, NORTH CAROLINA.
NORTHERN NIGERIA 14
NORTHERN TERRITORY, AUSTRALIA 27, 72
NURSES, *see* PUBLIC HEALTH NURSES.
NURSES' TRAINING SCHOOLS, *see* PUBLIC HEALTH NURSES.

PAGE
O'Brien, Dr. H. R. ix, xii
Ohio 52, 120
Oil in Mosquito Control 109
Oil of Chenopodium 46, 48
Oriente, Salvador 110

Paijan, Peru 15
Panama (City) 88
Panama (Republic):
  Government appropriation for hookworm control 39
  Also ix, 3, 5, 48, 58
Panjampatti, Madras 69
Papantla, Mexico 11
Papua viii, 75–76
Pará *see* Lower Pará (Dutch Guiana).
Paraguay xii, 45
Parchman Penitentiary, Sunflower County, Mississippi 100
Pareja, Dr. Wenceslao 3, 63
Paris 58
Parker, George x
Parsons, Ethel xi
Paul, Dr. G. P. ix, 67
Payne, Dr. F. K. 66, 81
Payne, Dr. G. C. ix, 36, 46, 62, 63, 66, 81
Pernambuco (City) Brazil 13
Pernambuco (State) Brazil viii
Peru:
  Campaign against yellow fever 3–6, 106, 109
  Also xi, 15
    See also Names of towns, cities, and departments.
Petri Dish 92
Petritz, Dr. L. J. x
Philippine Hospital Ship:
  Expenditures 136–137
Philippine Islands xii, 45
Pigs, *see* Animals.
Pitt County Health Department, North Carolina 117
Piura (Department) Peru 4, 6
Poeciliidae, *see* Fish.
Poland:
  Fellowships 52
  Also 1
Porto Calvo, Brazil 13
Porto Rico:
  Field experiment in mosquito control 22
  Appropriation for tuberculosis sanitorium 37

PAGE

PORTO RICO—*continued*
  Government appropriation for public health.................. 37
  Also..ix, x, 36, 98
    See also QUEBRADILLAS, PORTO RICO.
PRAGUE INSTITUTE OF HYGIENE..........................50, 58, 61
PRINCES TOWN, TRINIDAD.................................... 81
PRUDDEN, DR. T. M.. vii
PUBLIC HEALTH EDUCATION:
  Extension courses... 52
  Expenditures 136–137, 144–147
    See also SCHOOLS OF HYGIENE.
PUBLIC HEALTH LABORATORY SERVICE:
  Expenditures..................................136–137, 146–147
  Also.. viii
PUBLIC HEALTH NURSES:
  Government training school in Rio de Janeiro...............59–60
  In county health work................................114, 117
PUBLIC HEALTH NURSES' INSTITUTES......................... 52
PUBLICATIONS ISSUED......................................61–64
PUERTO OBALDIA, PANAMA................................... 88
PURGATIVES, *see* Names of drugs.

QUEBRADILLAS, PORTO RICO................................ 78
QUEENSLAND:
  Hookworm infection survey..............................72, 75
  Also..27, 90
    See also Names of places.
QUININE:
  Experimental studies in Mississippi........................99–100
  Development of standard treatment for malaria.............. 100
  Dosage for adults and children.......................100–101
  Prophylactic treatment 101
  Discontinuance of free distribution.....................101, 102
  Demonstration campaign...............................101–102
  Per capita cost.. 102
  Standard quinine packets...............................102–103
QUITMAN COUNTY, MISSISSIPPI............................. 100

READ, F. M.. vii
RECTOR, N. H..x, xii
RED CROSS, *see* AMERICAN RED CROSS; SIAM.
REED, DR. WALTER.. 2, 3
Report Covering Experiments in Malaria Control, by C. C. Bass.... 66
Result of Hookworm Disease Prophylaxis in Brazil, by W. G. Smillie
  note 34, note 47, note 86
RICE, DR. J. L.. ix
RICHMOND, VIRGINIA.. 110
RICHMOND COUNTY, VIRGINIA:
  Hookworm surveys...28–30

PAGE

Rio Cobre Home, Jamaica ... 79
Rio de Janeiro (City) Brazil ... 2, 13, 59
Rio de Janeiro (State) Brazil ... viii, 35, 121
Rio Grande do Sul (State) Brazil ... viii, 121
Rivas (Department) Nicaragua ... 109–110
  See also La Puebla—Rivas, Nicaragua.
Roane County, Tennessee ... 118
Rockefeller, J. D., Jr. ... vii
Rockefeller Foundation:
  Gift to Harvard School of Public Health ... 50–51
Rockefeller Sanitary Commission ... 28, 32
Rockhampton, Queensland ... 75
Ropes, William ... x
Rose, Wickliffe ... vii, viii
Ruleville, Sunflower County, Mississippi ... 101
Russell, Dr. F. F. ... viii, 42, 57, 58

Salt, *see* Hookworms.
Salvador:
  Reconstitution of national health organization ... 40–41
  Fellowships ... 52
  Also ... ix, xi, 9, 10, 12, 48, 58, 90
    See also San Salvador, Salvador; Sonsonate, Salvador.
San Blas Indians ... 49, 87–88
San Salvador, Salvador ... 110
Sanatoria, *see* Commission for Prevention of Tuberculosis in France; Tuberculosis.
Santa Catharina, Brazil ... viii
Santa Cruz de Bravo, Mexico ... 11
Santa Fé, New Mexico ... 120
São Paulo (State) Brazil:
  County health service ... 36
  Also ... viii, 56, 121
    See also Sertãozinho County, São Paulo.
Sawyer, Dr. W. A. ... viii, 42, 63
Scarlet Fever ... 120
Schapiro, Dr. Louis ... ix, xii
Schick Test (for diphtheria) ... 117
Schools, *see* Children; County Health Work.
Schools of Hygiene ... 49–51
Schüffner, Dr. Wilhelm ... 45
Scott County, Kentucky ... 118–119, 119–120
Screening (of houses), *see* Malaria Control.
Sea-water, *see* Hookworms.
Segovia, Dr. J. C. ... 58

PAGE
Senegal, Africa 14
Serbs, Croats and Slovenes, Kingdom of 1
Sertãozinho County, São Paulo 121
Serum, *see* Yellow Fever.
Sewage Disposal Investigation 136
Siam:
  National Red Cross and hookworm control 42
  Hookworm infection surveys 76–77
  Also ix, xii
Sierra Leone, Africa 14
Smallpox 118–119
Smillie, Dr. W. G. xi, 33, note 35, 46, note 47, 48, 62, 64, 86, 91
Smith County, Tennessee 118
Soil Sanitation, *see* Latrines.
Sonsonate, Salvador 110
Soper, Dr. F. L. viii
South Arcot, Madras 69
South Canara, Madras 71
South Carolina:
  Free clinics 118
  Also x, 17, 56, 93, 97, note 113
Southern Nigeria 14
Southern States:
  Malaria control 15–22
  Re-infection surveys 27–28
  County health administration 55–56
  County health work 112–121
  Also 103
    See also Malaria Control.
Souza, Dr. G. H. de Paula 64
Spain 2
Spinden, H. J. 9
Stegomyia (Mosquito) 5–6, 10, 106, 109, 110
Stegomyia index, *see* Yellow Fever.
Sterilization of Carriers, *see* Malaria Control.
Stool Examination Technique, *see* Hookworm Disease, Diagnosis.
Strauss, Frederick vii
Strode, Dr. G. K. viii
Strongyloid Larvae 48, 91
Stuart, Edward 64
Sumatra:
  Results of hookworm control measures 79–80
  Also 45

PAGE

Sumter County, Alabama.................................. 98
Sunflower County, Mississippi......................100, 101–102
Surinam, *see* Dutch Guiana.
Swamimalai, Madras...................................... 69
Sweet, Dr. W. C...viii, xii

Talladega County, Alabama................................ 98
Tampico, Mexico..10, 11, 109
Tanjore, Madras.. 69
Tasmania..27, 72
Taylor, Dr. H. A... x
Tazewell County, Virginia................................ 114
Tennessee...........................x, xii, 56, 58, 93, note 113, 118
See also Names of counties.
Texas...................................x, 18, 56, 93, note 113
See also Bullard, Texas; Gladstell, Texas.
Tirunageswaram, Madras................................... 69
Top Minnow, *see* Fish.
Toxin-Antitoxin (for diphtheria)......................... 117
Trachoma... 118
Trichinopoly, Madras..................................... 69
Trichinopoly Jail, Madras................................67, 69
Trinidad:
  Government support of public health.................... 37
  Studies on hookworm eggs and larvae in the soil........81–82, 85–86
  Modified Baermann apparatus for recovering hookworm larvae from the soil...88–89
  Also...ix, 36, 46, 49
  See also Princes Town, Trinidad.
Tuberculosis:
  Sanatorium in Porto Rico................................ 37
  See also Commission for Prevention of Tuberculosis in France.
Tuscaloosa County, Alabama............................... 98
Túxpan, Mexico... 11
Typhoid Fever...30, 31, 118

United States Bureau of Entomology......................103, 104
United States Bureau of Fisheries.......................103, 106
United States Bureau of Plant Industry................... 103
United States Public Health Service....15–16, 56, 93, 102–103, 113
University of São Paulo (Brazil)—Institute of Hygiene.... 50

Vaccination.. 118
Vaccine, *see* Yellow Fever.
Vakkampatti, Madras...................................... 69

PAGE
Van Dine, D. L. 64
Vaughan, Dr. V. C. vii
Vaughn, Dr. E. I. ix, xi, 110
Venereal Diseases 117
Venezuela 13
Vera Cruz, Mexico 11, 109
Vere Area, Jamaica 78–79
Viability of Hookworm Eggs and Larvae, *see* Hookworms.
Victoria, Australia 72
Vincent, G. E. vii, 64
Virginia x, 17, 56, 93, 97, note 113, 120
  See also Richmond, Virginia; Richmond County, Virginia; Tazewell County, Virginia.
Virginia State Board of Health 28

Waite, Dr. J. H. 75
Warren, Dr. A. J. ix, 64
Washburn, Dr. B. E. ix, 48
Washington County, Maryland 57
Welch, Dr. W. H. vii
Wells, Dr. C. W. xii
West Africa 2
  See also Yellow Fever Commission to the West Coast of Africa.
West Indies viii, 2, 13, 36
  See also Names of islands.
West Virginia 56, 58, note 113
Western Australia 27, 72
White, Dr. J. H. xi
Williams, Dr. L. R. xi, 26, 64
Williamson County, Tennessee 119
Willis, Dr. H. H. 64
Willis Salt-Flotation Method, *see* Hookworm Disease, Diagnosis.
Wilson, Dr. D. B. x
Winsor, Dr. S. A. ix
Worm Counts 33–35, 46, 48
Wyatt, Dr. B. L. xi, 64
Wynaad—Nilgiri Tea Estates, Madras 67

Yeager, Dr. C. H. viii
Yellow Fever:
  Distribution of infection 1–3
  Stegomyia index 3, 4, 11
  Work of control in Peru 3–6

PAGE
YELLOW FEVER—*continued*
  Use of fish in controlling epidemic in Peru..............5–6, 106, 109
  Epidemics in Yucatan.. 6, 9
  International co-operation in control........................9–10
  Work of national departments of health...................... 10
  Mosquito control on Mexican Pacific Coast...................11–12
  Infection in Brazil...12–13
  Commission to West Africa...................................13–14
  Use of vaccine and serum....................................14–15
  Leptospira icteroides.....................................14–15
  Use of fish as anti-mosquito measure..................106, 109–110
  Use of oil.. 109
  Expenditures..136–137, 144–145
  Also..40–41
YELLOW FEVER ADVISORY COUNCIL.................................. x-xi
YELLOW FEVER COMMISSION TO THE WEST COAST OF AFRICA.....13–14
Yellow Fever—First and Last, by H. J. Spinden................note 9
YQUITOS, PERU.. 13
YUCATAN:
  Center of yellow fever infection............................ 6, 9
  Yellow fever in Maya civilization........................... 9
  Also..10, 11

UNIVERSITY OF MICHIGAN
3 9015 00732 6252